TM 11-5825-231-24

TECHNICAL MANUAL

ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT

MAINTENANCE MANUAL

DIRECTION FINDER SETS AN/TRD-23, AN/TRD-23A AND DIRECTION FINDER SETS AN/TRD-15 AND AN/TRD-15A

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1973

WARNING

RADIATION HAZARD

Co	60
Ni	63
Ra	226

Tube types OB2WA used in this equipment contains radioactive material. These tubes are potentially hazardous when broken; see qualified medical personnel and the Safety Director if you are exposed to or cut by broken tubes.

Never place radioactive tubes in your pocket.

Use extreme care not to break radioactive tubes while handling them.

Never remove radioactive tubes from cartons until ready to use them.

Refer to TM 11–5825–231–10 on handling, storage, and disposal of radioactive material.

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TECHNICAL MANUAL
No. 11–5825–231–24

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *31 August 1973*

ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT, MAINTENANCE MANUAL

DIRECTION FINDER SETS AN/TRD–23, AN/TRD–23A AND DIRECTION FINDER SETS AN/TRD–15, AN/TRD–15A

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CHAPTER 1

INTRODUCTION

1-1. Scope

This manual describes Direction Finder Sets AN/TRD-23, AN/TRD-23A (ch 1 through 4), AN/TRD-15, and AN/TRD-15A (ch 5) covering their functioning and organizational, direct support (DS), general support (GS), and field testing. It includes instructions for troubleshooting, testing, aligning, and repairing all units of the system which are not covered by other manuals. Operating instructions are contained in TM 11-5825-231-10.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Reporting of Equipment Manual Improvements

The reporting of errors, omissions, and recommendations for improving this manual by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commander, US Army Electronics Command, ATTN: AMSEL-MA-S, Fort Monmouth, NJ 07703.

NOTE

For applicable forms and records, refer to TM 11-5825-231-10.

1-4. Items Not Covered

a. The maintenance of Oscilloscope AN/USM-318(V)1 is covered in TM 11-6625-1703-15 and chapter 8 of this manual.

b. The maintenance of Receiver, Radio R-390A/URR is covered in TM 11-5820-358-35.

NOTE

Radio Receiver R-725/URR is a modified Receiver, Radio R-390A/URR.

1-5. Internal Differences in Models

Units which are different between the AN/TRD-23 and the AN/TRD-23A are listed below. Details of the differences between the individual units are discussed in chapter 2.

Unit	*AN/TRD-23*	*AN/TRD-23A*	*Reference paragraph*
Shelter, Electrical Equipment	S-280/G	S-280A/G	2-17
Cabinet, Electrical Equipment (primary console)	CY-4873/TRD	CY-6691/TRD	2-16
Cabinet, Electrical Equipment (secondary console)	CY-4873/TRD	CY-6690/TRD	2-16
Cabinet Electrical Equipment (communications console)	CY-4873/TRD	CY-6023A/G	2-16
Radio frequency Detector	RF-159/TRD	RF-159A/TRD	2-9
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Audio Signal Distribution Box (audio box)	J-2679/TRD	J-2872/TRD-23A	2-15

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Cabinet, Electrical Equipment (secondary console)	CY–4873/TRD	CY–6690/TRD	2–16
Cabinet Electrical Equipment (communications console)	CY–4873/TRD	CY–6023A/G	2–16
Radio frequency Detector	RF–159/TRD	RF–159A/TRD	2–9
Drive, Goniometer-Rotary Coupler	TG–126/TRD	TG–126A/TRD	2–6
Oscilloscope	120B	AN/USM–318(V)1	2–13
Audio Signal Distribution Box (audio box)	J–2674/TRD	J–2871/TRD–23A	2–15
Audio Signal Distribution Box (audio box)	J–2679/TRD	J–2872/TRD–23A	2–15

CHAPTER 2

FUNCTION

Section I. SYSTEM FUNCTIONING

2–1. General

a. Basic Principles.

(1) The Doppler direction finder system is based on Doppler's principle for wave motion. This principle shows that the frequency of a received signal differs from the frequency of the transmitted signal when the receiver is moving at a given velocity in the direction of wave travel. In an idealized Doppler direction finder system, the motion of the receiver could be obtained by moving an antenna in a circular path as shown in the figure 2–1.

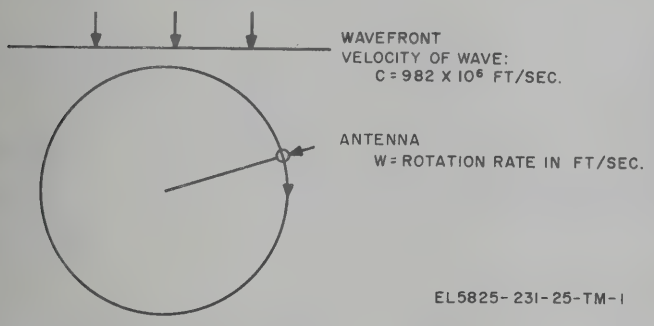


Figure 2–1. Doppler effect in rotating antenna.

(2) The frequency of the received signal would vary sinusoidally. It would be lower than the transmitted frequency during the time the antenna moves with the wavefront, and higher than the transmitted frequency when it moves against the wavefront. No change from the transmitted frequency will occur when the antenna moves perpendicular to the direction of arrival of the wave. Thus, if the phase of the frequency modulation envelope produced by the antenna motion is compared to a reference phase, the direction of arrival of the signal is determined.

(3) The antenna peripheral speed required to produce an adequate degree of frequency modulation would be impossible to attain in a single rotating antenna system. Therefore, the rotation of the single antenna is simulated by placing a number of fixed antennas in a circular array and scanning the signals from the antennas with a rotating pickup coil assembly.

(4) A signal from a distant transmitter induces voltages of equal amplitude in all antennas of the array. The phase difference between the signals in adjacent antennas is a function of the frequency and the direction of arrival of the signal. The word "phase" as used in the following description refers to the phase of a radio-frequency, (rf) signal at the point under discussion with respect to the phase of the same signal at a fixed reference point at the same instant of time. *For example,* the signals in the various antennas at any one instant would have a phase relationship as shown in figure 2–2 for the frequency, antenna spacing, and direction of arrival specified. The maximum phase step between adjacent antennas will be found between those which fall on a line which is most nearly parallel with the direction of wave travel, while the minimum phase step occurs between such antennas which fall on a line most nearly perpendicular to the direction of wave travel.

(5) The antennas of the array are scanned in sequence by a rotating coupling coil unit. Note that the vectors shown in figure 2–2 will be revolving with great rapidity with relation to the motion of the coupling coil rotor unit between adjacent antenna fixed coupling coils. However, at any one moment the *relative* phase relationships between the various antennas would be as shown in figure 2–2 for a given signal frequency. It is important to remember that the *relative* phase relationship between the various antennas will remain fixed as shown regardless of the time of viewing or the motion of the coupling unit.

(6) Signals from adjacent antennas are combined during the scan to produce a frequency-modulated (fm) signal. The frequency deviation at every instant is proportional to the size of the phase step between adjacent antennas. The phase of the envelope of the frequency modulation depends only on the direction of arrival of the signal from the distant transmitter. A bearing indicator compares the phase of the modulation

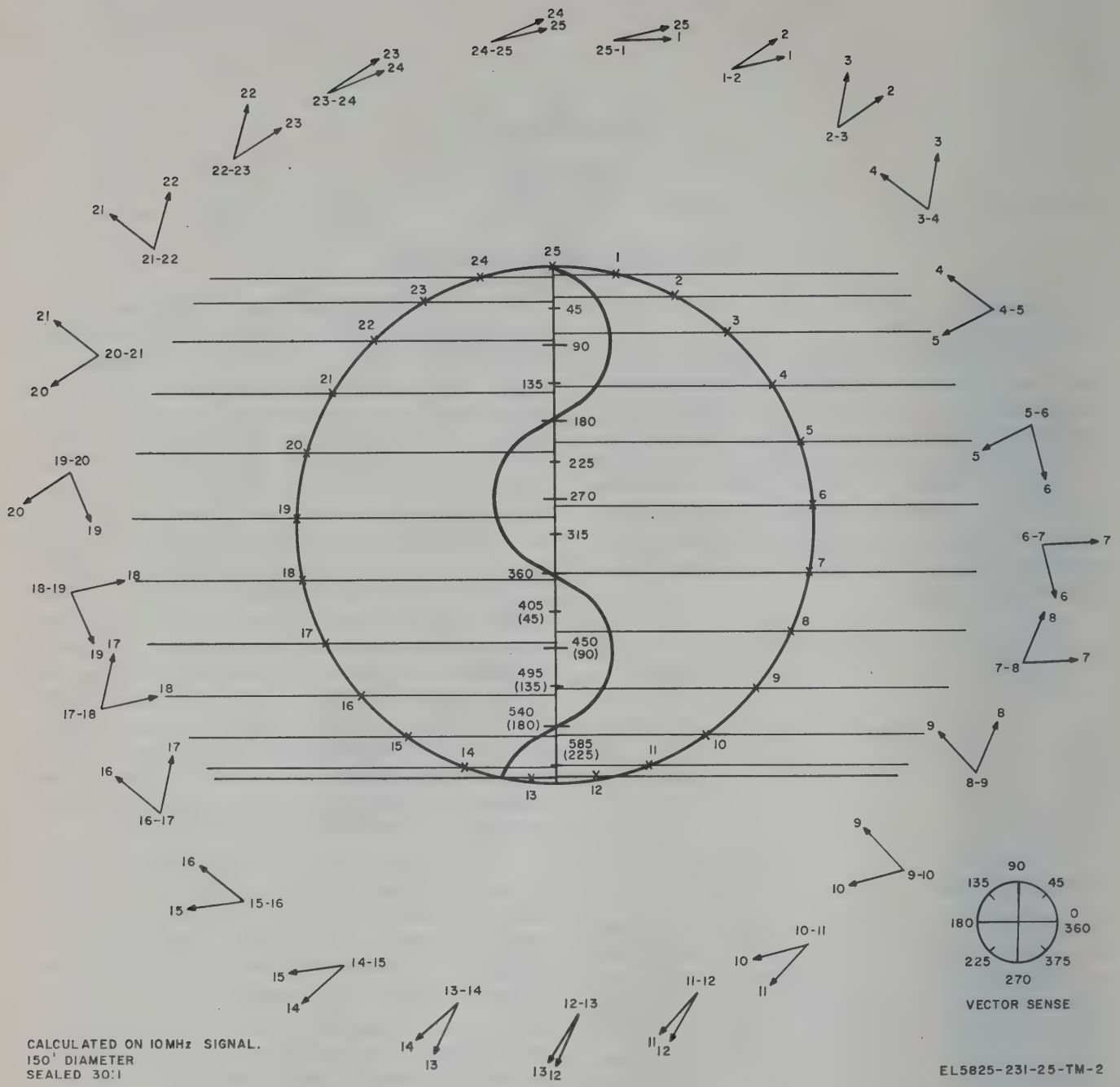


Figure 2–2. Phase relationship of signal in circular antenna array.

envelope with a reference phase and presents the bearing indication on a cathode-ray tube (crt).

b. The Quasi-Doppler Antenna System.

(1) The principle of operation of the Quasi-Doppler system is identical to the true Doppler system as described in *a* above with one variation. Instead of physically rotating an antenna, this function is simulated by sequential sampling around a circular array of antennas. (fig. 2–3)

(2) As long as the number of antennas is sufficient to satisfy the requirements of sampling function, this system permits an accurate reconstruction of the signal conditions of the true Doppler antenna configuration.

2–2. System Block Diagram
(fig. 2–4)

a. Direction Finder Set AN/TRD–23(*) has two signal interception sources, the monitor antenna and the direction finder (df) antenna. The monitor antenna serves as the signal intercept source for the two monitor receivers, the two

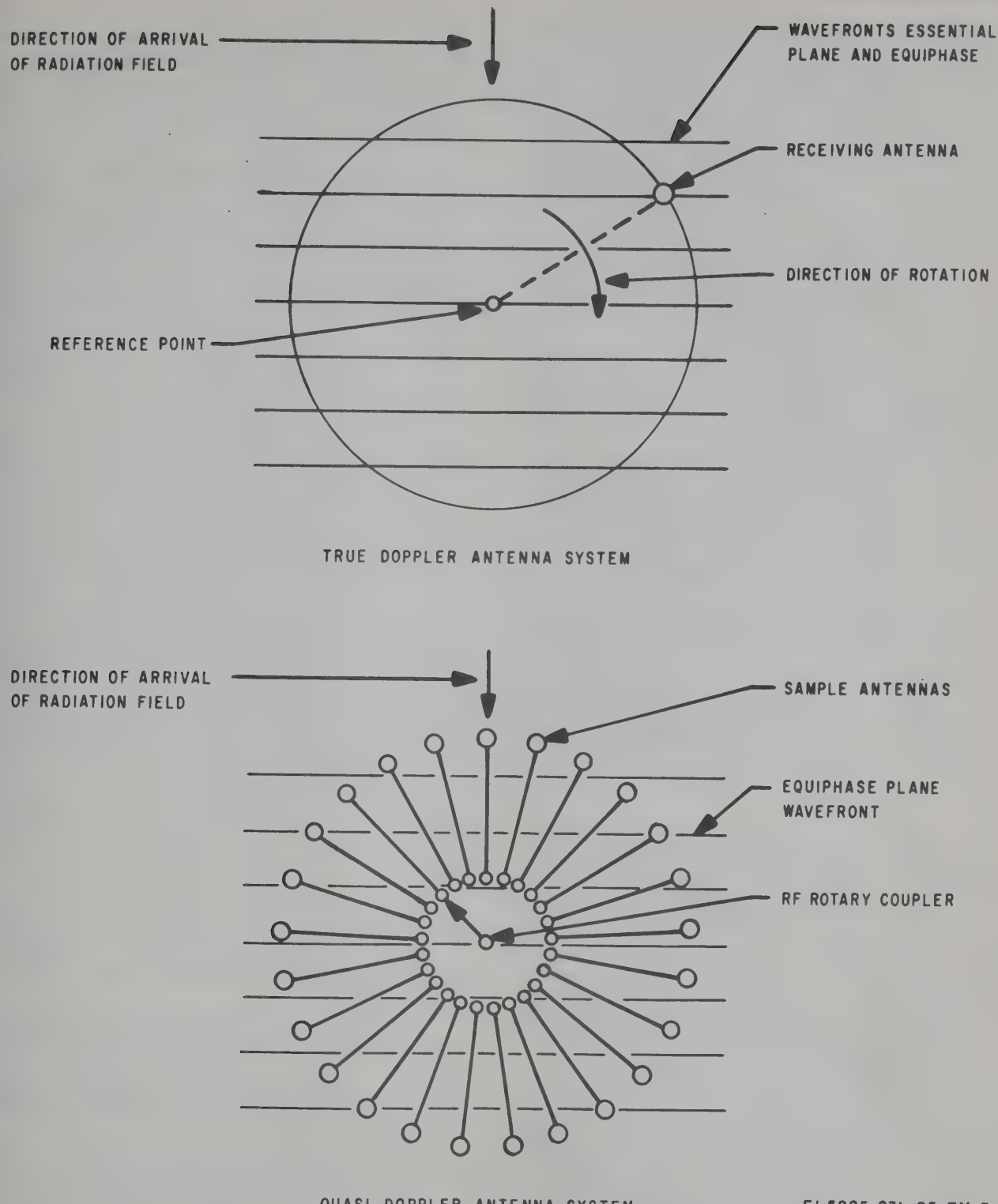


Figure 2–3. Direction finder antenna system.

net receivers, and the four df receivers in the MONITOR mode.

b. The number of receivers (eight) which may be connected to the monitor antenna presents a loading problem, so the antenna is connected to the receivers through an antenna coupler which provides impedance matching.

c. The df antenna and a rotary coupler function as a Quasi-Doppler antenna system as described in paragraph 2–1*c*.

(1) The rotary coupler sequentially samples the signal at each of the 25 antennas in the df antenna at a rate established by the 5,400 revolutions per minute (rpm) of the drive motor.

The rpm of the motor converts to 90 revolutions per second (rps) which is a 90 Hz frequency. The signal resulting consists of the signal source carrier, containing information modulation (such as amplitude modulation (am) fm, pulse modulation (pm) or frequency-shift keying (fsk)), which changes frequency due to the Doppler effect produced by the effective linear velocity of the sequencial sampling.

(2) This frequency change is minimum at the two points on the circumference of the df antenna intersected by a line through the center of the array and the signal source.

(3) As the rotary coupler completes 1 revolution, all 25 antennas in the array have been sampled, resulting in an fm signal at the output of the rotary coupler.

(4) The fm signal has a frequency of 90 Hertz (Hz) (the sampling rate). The maximum frequency deviation (change) of the carrier depends on the signal source frequency and effective linear velocity of the sequential sampling action of the rotary coupler.

d. The output of the rotary coupler is passed through the MONITOR-D.F. relays to the No. 1 df receivers (in the DF mode) in both consoles.

(1) The MONITOR-D.F. relays allow the use of the No. 1 df receiver as a monitor receiver when no df information is desired. The relays are operated by switches located on the azimuth indicator front panels.

(2) In the D.F. mode, the signal from the rotary coupler, containing the 90-Hz fm df information, is passed to the No. 1 df receiver where it is amplified and mixed to produce a 455 kiloHertz (kHz) intermediate-frequency (if.) signal. The 455-kHz if. signal then goes to the radiofrequency (rf) detector where the 90-Hz fm df information is extracted. The 455-kHz if. signal is also detected in the receiver to recover any am. transmitted from the signal source.

e. The 455-kHz if. signal enters the rf detector where it is limited to remove any am. present, mixed with another 455-kHz signal from an internal oscillator or the No. 2 df receiver (in the two-receiver (2-RCVR) mode). The product of this mixing is then detected, producing the 90-Hz df signal introduced by the Quasi-Doppler antenna array (fig. 2–3).

f. The signal for the No. 2 df receiver comes from the monitor antenna and therefore does not contain the 90-Hz df modulation. It does contain any am., fm, pm, or fsk modulation from the signal source. The No. 2 df receiver produces a 455-kHz if. signal the same way as the No. 1 df receiver. In the 2-RCVR mode of operation, the output of the No. 2 df receiver is substituted for the output of the 455-kHz oscillator in the rf detector by energizing the 1 RCVR-2 RCVR relays. These relays are controlled by a switch on the azimuth indicator front panel.

g. In the 2-RCVR mode, the output of the No. 2 df receiver enters the rf detector, is limited to remove any aM. present, and then mixed with the signal from the No. 1 df receiver, which has been processed in a similar way. When these two signals mix, all fm, pm, or fsk modulation from the signal source, which is common to both channels, cancels. The only modulation which does not cancel is the 90-Hz df which comes only from the No. 1 df receiver.

h. The 90-Hz df signal output of the rf detector goes to the azimuth indicator where it modulates the 72-kHz sweep, and provides blanking to remove the ambiguous half of the display. The 90-Hz df signal is doubled in frequency and used to control a modulator which allows the 72-kHz sweep to reach the goniometer only when the 90-Hz df signal is the point of zero frequency change generated by the Quasi-Doppler df antenna. Since zero frequency change occurs when the antenna which is closest to or farthest from the signal source is being sampled, the goniometer and indicator receive the 72-kHz sweep only when the rotary coupler is sampling these two antennas. The signal from the antenna farthest from the signal source does not affect the display because of the action of the blanking circuit in the azimuth indicator.

i. The 72-kHz sweep leaves the azimuth indicator modulator and goes to the goniometer, where it is transformed into two phases, 90° apart, and then returned to the azimuth indicator deflection circuits.

(1) The goniometer is a rotary transformer with a rotating primary winding and two stator secondary windings. As the primary winding rotates, the output of the two secondary windings changes.

(2) The goniometers are rotated at 90 rps by the same motor which drives the rotary coupler, and a precise angular relationship is maintained between them. Therefore, when the rotary coupler is sampling a particular antenna, the goniometer primary has a corresponding relationship to the two secondary windings.

(3) The outputs of the secondary windings of the goniometer go to the deflection plates of the crt in the azimuth indicator. The 90° phase difference between the two secondary windings causes (in the absence of df modulation) the 72-

kHz sweep to trace out a rotating line on the crt, creating a circular display (fig. 2–5). The speed of rotation and the angular position of this line at any instant have an exact correspondence with the rotary coupler.

j. Signal waveforms and display are shown in figure 2–5.

(1) The time relationship between the various waveforms involved in the direction finding process are shown.

(2) Waveforms A, B, and C show the unmodulated 72-kHz sweep output and how the goniometer affects it, producing the circular display at the right.

(3) The time scale shows that the 90-Hz df signal (D) crosses zero (changes phase) at 45° and 225°. This signal is doubled in frequency (E) and used to control the sweep modulator, allowing conduction only during the positive portions of the cycles, and produces the 72-kHz sweep output shown at F. Note that these bursts occur at 45° and 225°, the same as the crossover points of the df signal.

(4) The signal at F goes to the goniometer and comes out as G and H, which produces the propeller-shaped pattern shown at the right. Note that G and H are in phase. The 90° phase difference between the two secondary windings of the goniometer controls the relative amplitude and phase of the sweep fed to the deflection plates (not the time). The second half of the propeller pattern does not appear because of the effect of the blanking circuit.

k. The drive motor turns the primary and secondary goniometers, the rotary coupler, and the sync pulse generator.

(1) The drive motor is powered by the control amplifier which produces a 180-Hz signal of sufficient power to run the motor.

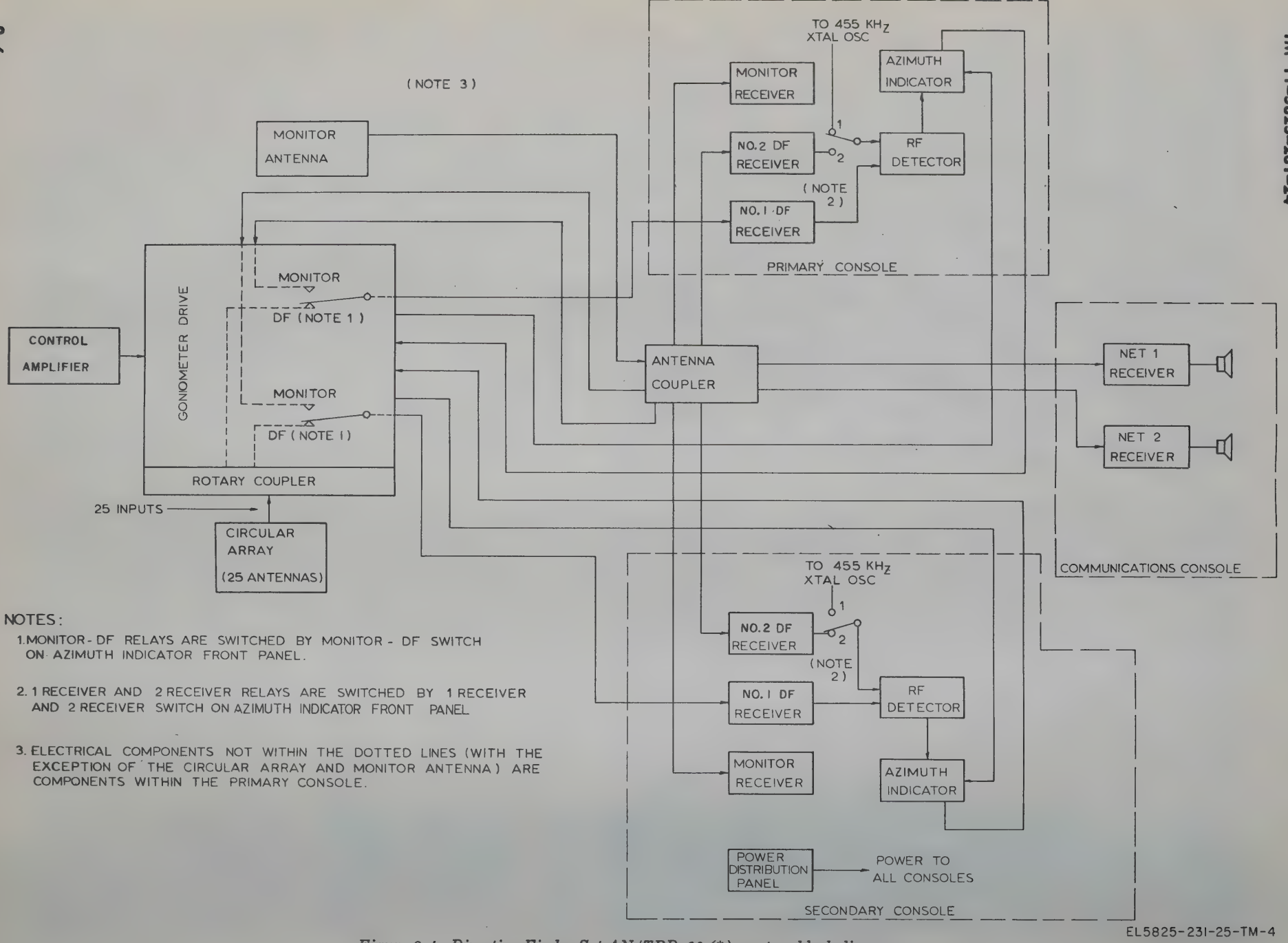
(2) The sync pulse generator produces a pulse for every revolution of the rotary coupler. This pulse is used to synchronize the monitor oscilloscope to the rotation of the rotary coupler.

(3) The monitor oscilloscope displays the 455-kHz output of the secondary No. 1 df receiver and, because of synchronization with the rotary coupler, indicates the condition of the df antenna, the rotary coupler, and No. 1 df receiver.

l. The communications console provides two radio receivers for monitoring communications signals from the monitor antenna.

m. The power panel provides adjustable power for all units metered to monitor the voltage and frequency.

n. The target transmitter is a battery-powered radio transmitter which is used as a signal source for calibrating and checking the system in the field.



NOTES:

1. MONITOR - DF RELAYS ARE SWITCHED BY MONITOR - DF SWITCH ON AZIMUTH INDICATOR FRONT PANEL.
2. 1 RECEIVER AND 2 RECEIVER RELAYS ARE SWITCHED BY 1 RECEIVER AND 2 RECEIVER SWITCH ON AZIMUTH INDICATOR FRONT PANEL
3. ELECTRICAL COMPONENTS NOT WITHIN THE DOTTED LINES (WITH THE EXCEPTION OF THE CIRCULAR ARRAY AND MONITOR ANTENNA) ARE COMPONENTS WITHIN THE PRIMARY CONSOLE.

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Figure 2-4. Direction Finder Set AN/TRD-23 (*), system block diagram.

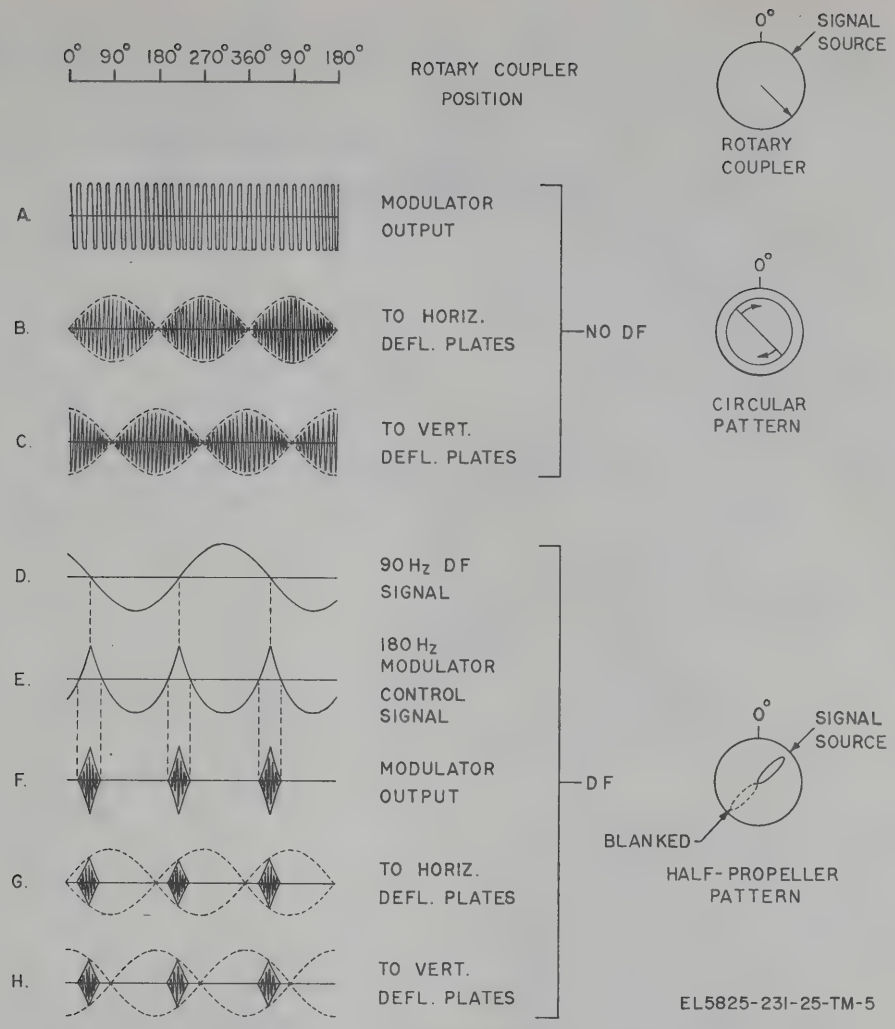


Figure 2–5. Signal waveforms and display.

Section II. UNIT FUNCTION

2–3. General

a. The system block diagram was discussed in paragraph 2–2. This section will discuss the individual units in detail.

b. Differences between units in the two models of the direction finder set are detailed in the following paragraphs. To determine which units are affected, refer to paragraph 1–4.

2–4. Antenna System AN/TRA–32

(fig. 2–6)

a. The receiving antenna system consists of a series of vertical monopoles arranged on the circumference of a circle having a radius of 75 or 150 feet. Twenty-six vertical monopoles make up the entire system. Twenty-five monopoles are located at equal distances along the circumference of the circle; the remaining one (the monitor antenna) is near the center of the circle.

b. The circular arrangement of the 25 receiving antennas (the df antenna) permits the interception of wavefronts on a time sequence basis, so that a line drawn from the center of the circle through the point of initial wavefront interception along the circumference will intersect the transmitting source. To establish this point of entry, the signal of interest is sampled from each antenna in sequence 90 times per second (90 Hz), which, because of the Doppler effect, causes the signal to be frequency modulated. The frequency of the modulation is the sampling rate (90 Hz). The frequency deviation (change) produced depends on the frequency of the signal source.

c. The single antenna within the circular array, called the monitor antenna, is used for monitoring, or cancellation of interfering modulation. As a monitor, it provides signals undisturbed by the rotational sampling process. When modulation is present on the signal source carrier which

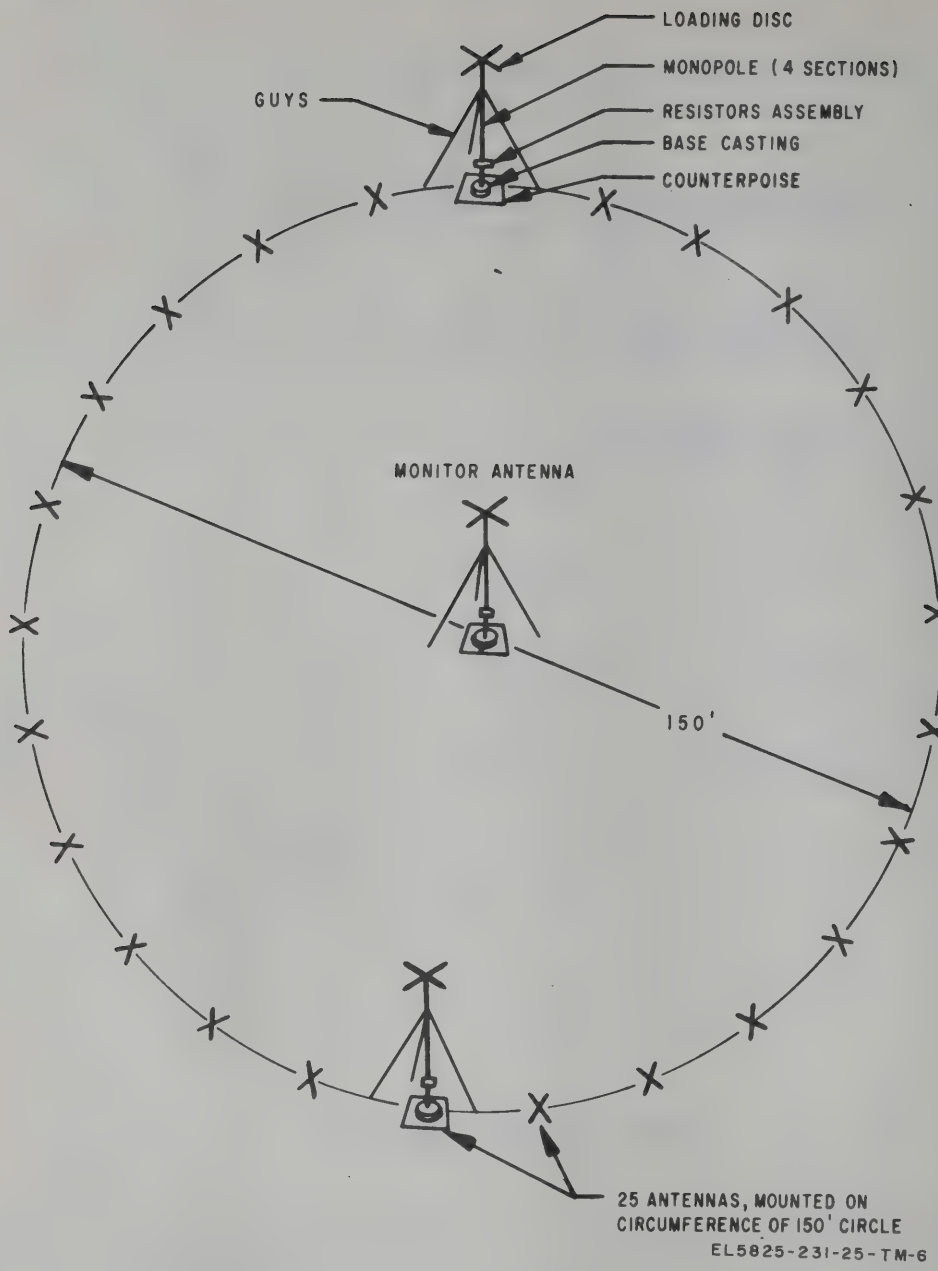


Figure 2–6. Antenna system diagram.

interferes with the direction finding function, such as fm, the signal from the monitor antenna may be used for canceling purposes (two-receiver mode).

d. Each monopole exhibits the normal resonance and impedance characteristics of a thin wire antenna. The receiving pattern is essentially circular (omnidirectional) modified to some extent by the interaction of the remaining antennas in the array. Sensitivity of the system depends on frequency, and is maximum when the antennas are resonant. A momopole without the loading section is resonant at approximately 10 megaHertz (MHz). The addition of the loading section lowers the resonant frequency to about 6 MHz. The lower section of each monopole contains a resistive impedance-matching assembly terminating in an N-type connector to match the characteristic impedance of the antenna to the transmission line. All elements are matched to 50 ohms impedance to minimize interconnection losses at radiofrequencies.

e. Each monopole is supported by three guy wires, which constitute antennas in themselves. Be sure insulated separators are installed so that no continuously conductive wire is longer than one-quarter wave-length of the highest frequency of interest.

f. Each monopole is equipped with a 10-foot square wire mesh counterpoise which is installed

beneath the base of the antenna. This is connected to the ground side of the antenna matching section to provide an effective ground plane.

2-5. Coupler Antenna CU-1874/TRD-23A

a. The antenna coupler provides for the connection of as many as eight receivers to the monitor antenna without excess loading of the antenna.

b. The block diagram (fig. 2-7) shows that rf input signals are fed from the monitor antenna through input jack J9, to variable bandpass filter FL2. The signal is amplified in the rf amplifier and passed through the isolation amplifier to eight individual output transformers. A self-contained power supply and a metering circuit are also provided.

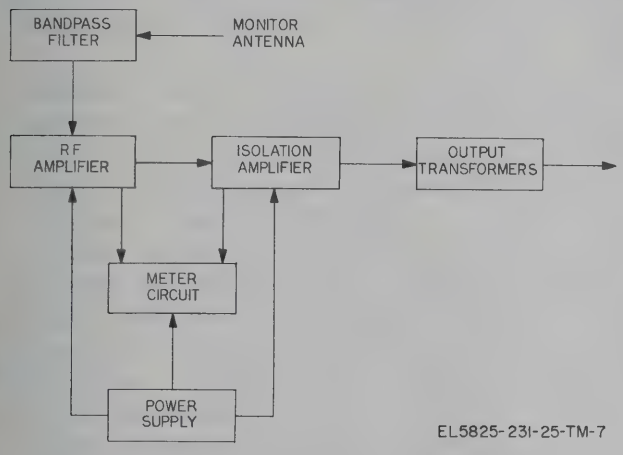


Figure 2-7. Antenna coupler, block diagram.

c. Stage analysis (fig. FO-21) is as follows:

(1) Input filter FL2 between input jack J9 and the input to the rf amplifier is a combination high-pass and low-pass filter which provides a bandpass of 2 MHz to 32 MHz.

(2) The rf amplifier is a transformer-coupled common-base, push-pull amplifier. Variable resistors R6 and R7 set the base bias and balance the circuit. Capacitors C11 and C12 correct imbalance which produces distortion.

(3) The isolation amplifier is a transformer-coupled, push-pull, emitter-follower circuit that provides a low-impedance output for the coupler. Variable resistors R3 and R4 set the base bias on transistors Q1 and Q2.

(4) The TEST METER can monitor the condition of the two amplifiers and the power supply through suitable switching.

(5) The power supply operates from 115-230 volt, 60-Hz source which enters through powerline filter FL1. A full-wave bridge rectifier supplies drive voltage for the two amplifiers, and a Zener regulated 10-volt source is provided for transistor bias.

2-6. Drive, Goniometer-Rotary Coupler TG-126(*)/TRD

a. General. Two models of this unit are available. The TG-126/TRD is used in the AN/TRD-23, and the TG-126A/TRD is used in the AN/TRD-23A. Electrically, the units are identical, and the information in *b* and *c* below applies to both. Although improvements in the sync pulse generator have been made in the TG-126A/TRD, the units are interchangeable.

b. Block Diagram (fig. 2-8).

(1) The goniometer drive is an assembly of the following mechanically linked units which are driven by a synchronous motor:

Coupler, Rotary, Radiofrequency (rotary coupler)	CU-1096/TRD
Goniometer, Electrical (primary goniometer)	GO-42/TRD
Goniometer, Electrical (secondary goniometer)	GO-42/TRD
Sync pulse generator	P/O CU-1096/TRD
Drive motor	

NOTE

The chassis also contains the Primary and Secondary MONITOR-D.F. relays.

(2) The motor is driven by a 180-Hz voltage supplied by the control amplifier through a phase shift network which produces the phases necessary to drive the motor.

(3) The rotary coupler, which is driven by the motor, passes the signal from each antenna of the df antenna sequentially as it turns. This sampling process produces the Doppler effect of a Quasi-Doppler antenna system, and the signal leaving the rotary coupler consists of the signal source carrier, the signal source modulation (am., fm, pm, or fsk), and the df fm signal from which will be found the direction of the signal source.

(4) The two outputs of the rotary coupler (180° out of phase) go through the MONITOR-D.F. relays. The position of these relays, controlled by the MONITOR-D.F. switches on the azimuth indicators, determines whether the No. 1 df receivers use the monitor antenna or the df antenna as signal sources.

(5) The primary goniometer is driven by the motor. It receives the df modulated 72-kHz sweep signal from the primary azimuth indicator, and transforms it into two phases 90° apart. The angular position of the goniometer determines the amplitude and phase of the sweep signal output on each secondary. The outputs of the goniometer are fed to the horizontal and vertical deflection plates of the azimuth indicator.

(6) The secondary goniometer is belt driven from the primary goniometer and functions the same way; that is, processing signals from the secondary azimuth indicator.

(7) The sync pulse generator is driven from the secondary goniometer, and produces a pulse every revolution. The pulse is then shaped and passed to the monitor oscilloscope to provide syncronization with the entire drive chain.

c. Stage Analysis (fig. FO–9).

(1) *Rotary coupler* (fig. 2–9 and 6–3).

(*a*) The rotary coupler provides the necessary facility for sampling the radiofrequency energy from each of the 25 antennas in sequence and passing the resultant information on to the No. 1 df receiver for further processing.

(*b*) Each of the 25 antennas is connected sequentially to each of the 25 transformer primary windings in the rotary coupler stator. The stator primaries are wound on half-torroid sections of ferrite core material spaced equidistant from each other and the perpendicular axis. The rf transformer is complete when a stator half core is in perfect alignment with one of the two mating cores spaced 180° apart on the rotor. The rotor half cores are continuously coupled magnetically to two similar stationary output windings wired to output connectors.

(*c*) Radiofrequency signals from each of the 25 antennas appear at each of the 25 rotary coupler primary stator windings, and are coupled in turn to the 180° displaced secondary windings resulting in an rf signal modulated by the frequency of rotation of the rotor, which is 90 Hz. A second transformer action takes place when the outputs of the two rotor coils are connected to the two coaxial primaries of output transformers. Continuous coaxial coupling takes place between the primary and secondary windings of the two output transformers so that outputs are extracted from this rotary device without the use of normally troublesome slipsprings. The output secondaries are connected to convenient connectors for signal routing to the system for additional processing.

(2) *Primary goniometer* (fig. 6–4). The primary goniometer is a rotary transformer which accepts, at the primary, a 72-kHz sweep signal from the azimuth indicator and produces, across the secondary windings, two 72-kHz signals displaced in phase 90° from each other. These signals, rotating in phase at a 90-Hz rate, are fed to the horizontal and vertical plates, respectively, of the indicator tube where they are displayed as a filled-in circle as the result of a radial sweep line. When df information is present, the amplitude and phase of the sweep signal bursts from the azimuth indicator are modified by the angular position of the goniometer to produce a propeller shaped display. The rotation of the rotary coupler and the primary goniometer is precisely synchronized so that a wave front passiny over the antenna array from a given direction results in an indicator deflection which causes the pattern to point in precisely that direction.

(3) *Secondary goniometer* (fig. 6–4). A second goniometer, identical with the primary goniometer functionally, is belt-driven from the primary goniometer. This unit is timed precisely with the rotary coupler to present accurate df display on the secondary azimuth indicator. The 72-kHz sweep signal, derived from the secondary azimuth indicator unit, is processed in the secondary goniometer the same way as the primary unit.

(4) *Magnetic pickup* (fig. FO–9). Mechanically coupled to the secondary goniometer is magnetic pickup device PM1, which provides a pulse for every revolution of the goniometer. This is accomplished by passing a magnet in close proximity to a pickup coil once every revolution. The magnetic lines of force cut by the turns of wire induce a voltage in the coil in the form of a steep-sided pulse. The excursion of the pulse is limited by diodes CR1 and CR2, while the final shaping of the pulse is determined by differentiating network C1 and R1. The processed pulse is passed on, through cable from J1, to the monitor oscilloscope to provide sweep synchronization with the rotary driven units. The magnetic pickup is positioned mechanically to produce a pulse at the time the No. 1 (North) antenna is being coupled through the rotary coupler.

(5) *Relay operation* (fig. FO–9).

(*a*) *Primary MONITOR-D.F. relay.* Relays K1 and K2 permit the operator to select a received signal without direction finding information by shifting the input of the primary No. 1 df receiver to the monitor antenna. Direction finding information from the df antenna and rotary coupler is normally fed through relay K1 to the balanced input of primary No. 1 df receiver. When azimuth indicator switch S3 in the primary console is set to MONITOR, 6.3 volts alternating current (ac) is applied through J5 to rectifier CR3 and filter C4, providing a (dc) voltage which energizes K1 and K2. When energized, K1 disconnects the rotary coupler output from the balanced input of the No. 1 df receiver and connects a dummy load (R2 and R3) to the balanced input. Relay K2 disconnects the dummy load

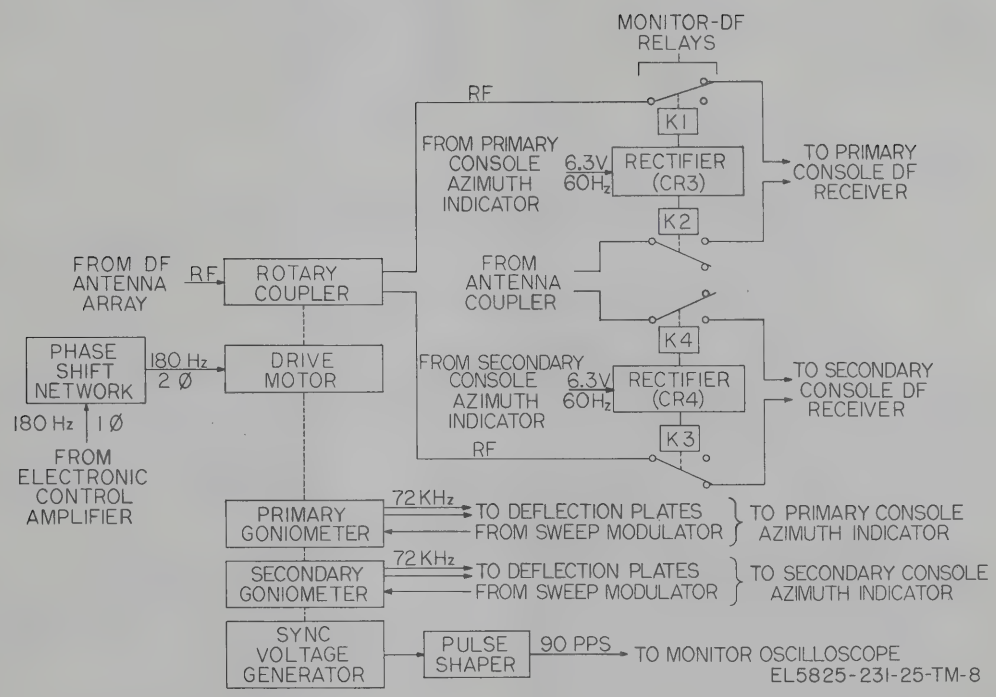


Figure 2–8. Gonimeter drive, block diagram.

(AT1) from the unbalanced input of the No. 1 df receiver, and connects the signal from the monitor antenna to the unbalanced input. The output of the rotary coupler which enters the drive chassis through cable at J3 is optionally switched by K1, leaves at J4, and reaches the balanced input of the No. 1 df receiver through connecting cable. The output of the monitor antenna enters the chassis through cable at J6, and at the option of K2 leaves at J7 reaching the unbalanced input of the No. 1 df receiver by way of connecting cable.

(*b*) *Secondary MONITOR-D.F. relay.* Relays K3 and K4 permit the operator to select a received signal without direction finding information by shifting the input of the secondary No. 1 df receiver to the monitor antenna. Direction finding information from the df antenna and rotary coupler is normally fed through relay K3 to the balanced input of the secondary No. 1 df

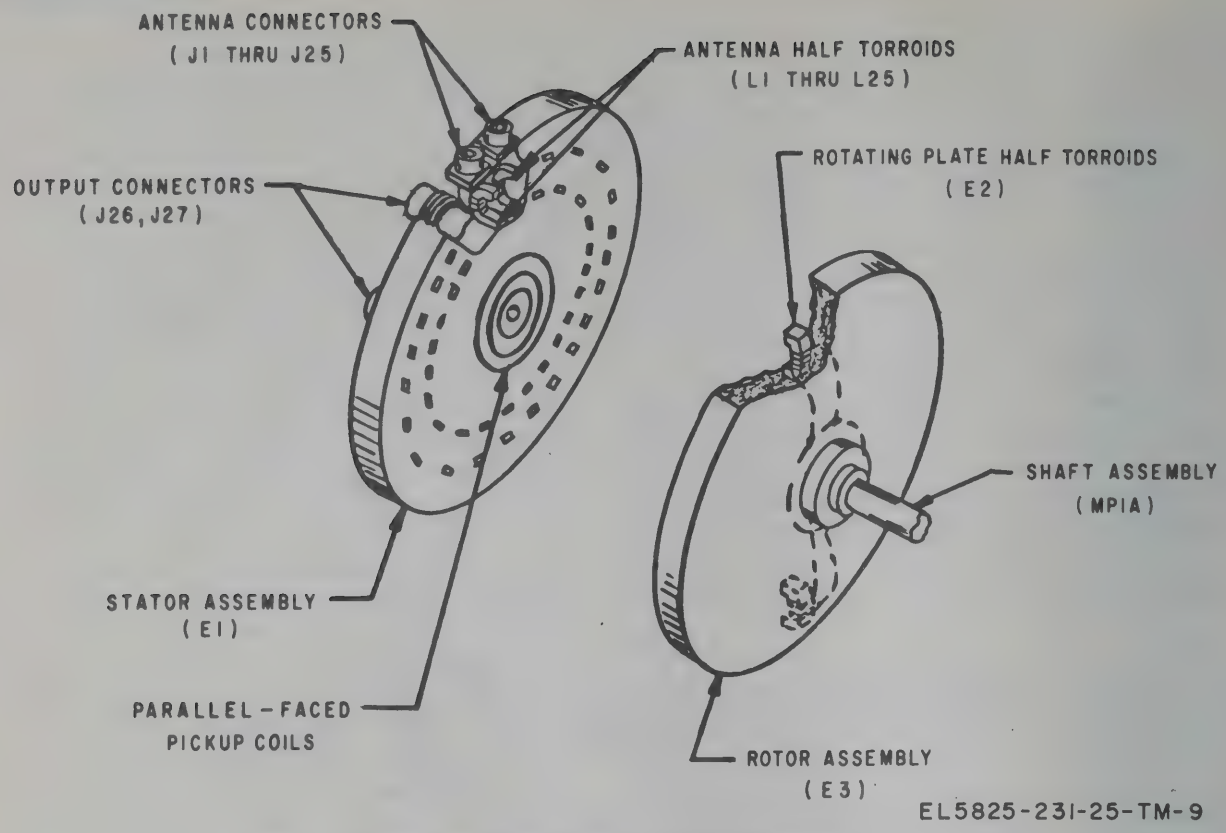


Figure 2–9. Rotary coupler, pictorial diagram.

receiver. When azimuth indicator switch S3 in the secondary console is set to MONITOR, 6.3 volts ac is applied through J10 to rectifier CR4 and filter C5, providing a dc voltage which energizes K3 and K4. When energized, K3 disconnects the rotary coupler output from the balanced input of the No. 1 df receiver and connects a dummy load (R4 and R5) to the balanced input of the receiver. Relay K4 disconnects the dummy load (AT2) from the unbalanced input of the No. 1 df receiver, and connects the signal from the monitor antenna to the unbalanced input. The output of the rotary coupler enters the drive chassis through cable at J8, is optionally switched by K3, leaves at J9, and reaches the balanced input of the No. 1 df receiver through connecting cable. The output of the monitor antenna enters the chassis through cable at J11 and, at the option of K4, leaves at J12 reaching the unbalanced input of No. 1 df receiver by way of connecting cable.

(6) *Motor* (fig. FO–9). Motor B1 is a split-phase, synchronous-type requiring 115 volts at 180 cycles per second for operation. The power needed to drive the motor is supplied by the control amplifier by cable through input at J13. Capacitor C3 adjusts the overall power factor to a reasonable value while C2 provides the necessary 90° phase shift to enable the two-phase motor to operate from a single-phase source. The double-ended motor shaft permits driving the rotary coupler and primary goniometer directly.

2–7. Amplifier, Electronic Control AM–3345/TRD

a. Block Diagram (fig. 2–10).

(1) The control amplifier contains a tuning fork voltage source and an appropriate power amplifier to raise this signal to a level to drive the goniometer drive motor.

(2) The 180-Hz output from the tuning fork is fed to an isolation stage and a safety circuit. After enough power amplification, the elements of the output stage are switched alternately into conduction to provide the voltage swing across the output transformer secondary necessary to drive the motor.

(3) The safety circuit continuously monitors the load on the amplifier output and is above or below a preset level it will shut down the signal fed to the output stage.

(4) The power supply provides dc voltage for the power stages. Regulation is provided to protect the low level stages from large voltage variations.

b. Stage Analysis (fig. FO–1).

(1) This unit has a soid-state amplifier consisting of control, voltage amplification, driver,

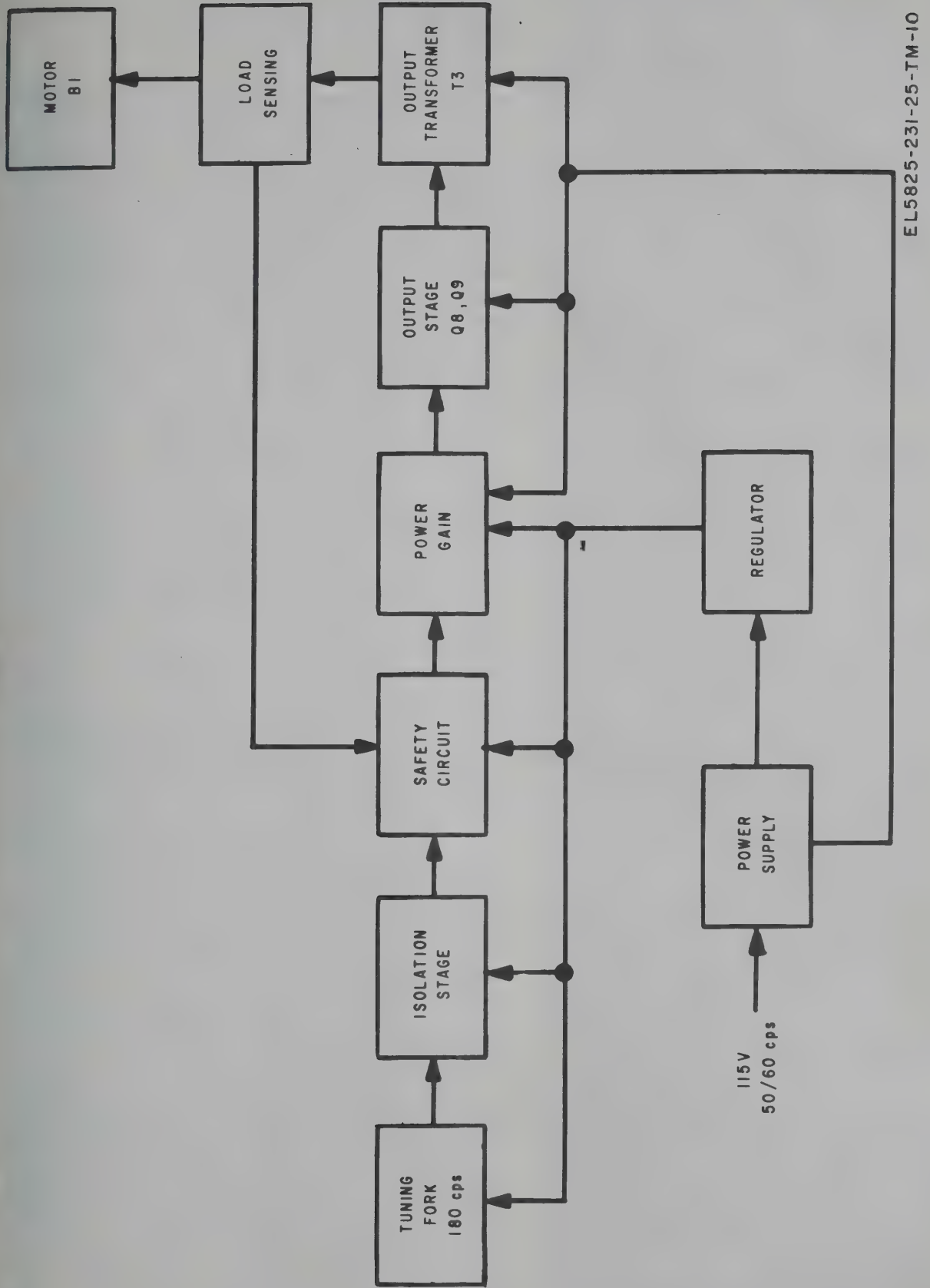


Figure 2-10. Control amplifier, block diagram.

and power output stages energized by the self-contained dc power supply. A source of 115-volt, 60-Hz power is required, which connects at J1.

(2) Line power is applied to power transformer T4 and fan motor B1 by way of on-off switch S1 and 8-ampere fuse F1. Rectifiers CR8 and CR9, in a full-wave configuration, supply dc voltage for energizing the tuning fork and the stages of the amplifier after filtering by choke L1 and capacitors C10 and C11. Resistor R27 is a load resistance across the dc supply voltage. Transistor Q10 is a series voltage-regulating element to maintain a constant dc voltage supply for the tuning fork, and stages Q1, Q2, Q3. Resistor R18 establishes appropriate current flow for reference Zener diode CR5, which provides a fixed base bias voltage for transistor Q10. Filtering of this voltage is accomplished by capacitor C5.

(3) Dc voltage is fed to socket XMP1 at pins 7 and 6 (GRD) to energize plug-in tuning fork MP1. The tuning fork output (180Hz) is taken at pins 9 and 6 and fed through coupling capacitor C1 to the base of first emitter-follower transistor Q1. From the arm of divider R4 in the emitter of Q1, the output is passed through diodes CR1 and CR2 before reaching the base of second emitter follower Q3. Decoupling from the dc levels established by dividers R5, R6, R10, and R11 is accomplished by capacitors C2 and C3.

(4) The output (partially squared 180 Hz voltage) from the emitter of second stage Q3 is fed through coupling capacitor C4 to the primary of transformer T1, where coupling and waveshaping is provided for the push-pull input to the bases of Q4 and Q5. Resistor R17 provides the proper input impedance for the push-pull voltage amplifier stage Q4, Q5.

(5) Interstage transformer T2 provides coupling from the output (collector to collector) of Q4, Q5 to the input (base to base) of driver stage Q6, Q7. The collectors of driver stage are direct coupled to the bases of push-pull power output stage Q8, Q9 where sufficient 180-Hz power is developed to drive the synchronous motor.

(6) The output transformer T3 provides the appropriate turns ratio and impedance to transform the power developed in the output stage to a voltage and current (115 volts at 1 ampere) to match the requirements of the motor load. Transformer T3 also serves to decouple the output from the dc supply voltage.

(7) Resistors R19 through R22 provide bias voltages for the driver and output stages while R23 and R24 limit the emitter current in the latter. Resistor R26 drops the 115 volts, 180 Hz output voltage to illuminate neon indicating lamp DS1. The amplifier is protected from loads in excess of 1 ampere by fuse F2 in the output.

(8) Additional protection for the amplifier is provided by an output current monitor circuit. The output current is sensed across R25 and rectified by diodes CR6 and CR7. The negative voltage thus developed is passed to the base of switching transistor Q2. Also appearing on this base is a positive voltage which has been developed across CR3 and CR4. When the output load is correct, these voltages balance out slightly negative, keeping transistor Q2 cutoff. In a no-load condition, no negative voltage is developed across CR6 and CR7 to balance out the positive voltage from the tuning fork; thus, the base of Q2 goes positive and it begins conducting, shorting the isolation amplifier output to ground, removing signal input to the driver and output stages. When the load begins to draw excessive current, sufficient negative voltage is developed by CR6 and CR7 to overcome the positive voltage across CR4. This action causes CR3 to become forward biased, and shorts the tuning fork output directly to ground.

2–8. Receiver, Radio R–725/URR

a. General.

(1) For a detailed discussion and circuit analysis of the R–725/URR, refer to TM 11–5820–358–35 which covers Receiver, Radio R–390A/URR. The information is unchanged except as listed below.

(*a*) A hum-bucking circuit has been added to the R–390A/URR as shown in figure 6–5 to improve performance. This modification places a positive dc voltage on the filament of the variable frequency oscillator (vfo) (V701) in the receiver, reducing the heater-to-cathode leakage of 60 Hz into the signal.

(*b*) The if. amplifier subchassis has been replaced in its entirety. Refer to *b* and *c* below for detailed discussion of this chassis.

(2) The receiver provides continuous-wave (cw), modulated continuous wave (mcw), and am. reception over a frequency range from 0.54 to 32 MHz. The receiver is basically a superheterodyne of the multiple conversion type. Triple conversion is used for lower frequencies (0.5 to 8 MHz). The receiver normally operates from a self-contained power supply designed to operate at a nominal input of 115 or 230 volts over a frequency range from 48 to 62 Hz. However, provision is made to use a dynamotor in

place of the ac power supply for dc operation.

(3) The tuning system of the R–725/URR provides linear tuning over the entire frequency range of the receiver. Permeability tuning (insertion of powered-iron cores into coils) and a system of gears and cams make linear tuning possible and permit the use of a counter-type indicator on the front panel to show the frequency selected.

(4) The receiver power supply provides dc for the antenna and break-in relays, ac to the filament and oven circuits, and B+ voltage to the voltage regulator circuit. All B+ voltages supplied to the receiver are regulated. The voltage regulator circuit consists of a series regulator, a dc amplifier, and voltage reference tubes. The power supply consists of a transformer and two rectifiers. The transformer has two primary windings which are connected in series for 230-volt operation, and in parallel for 115-volt operation.

b. If. Strip Block Diagram (fig. 2–11).

(1) The if. subchassis contains six voltage amplifier stages, a detector, automatic gain contro (agc), beat frequency oscillator (bfo), limiter, and cathode-follower output stages.

(2) A 455-kHz signal from the third mixer of the main receiver is amplified by the first five stages of the if. amplifier. The output of the fifth stage goes to the agc circuit, the sixth if. amplifier, and the cathode-follower output stage, which supplies the 455-kHz signal to the rf detector.

(3) The output of the sixth if. stage is mixed with the output of the bfo, detected, and passed through a limiter to the audio amplifier on the main chassis.

c. If. Strip, Stage Analysis (fig. FO–4).

(1) The 455-kHz signal from the third mixer in the main receiver enter the if. chassis at J518. The signal is then routed to the first if. amplifier through cyrstal filter Z501. For the two narrow pass bands, 0.1 and 1 kHz, the crystal filter is used. Four additional degrees of selectivity which do not use the crystal filter are accomplished in the if. stages by the BANDWIDTH KC switch which varies the coupling between the primary and secondary circuits of the if. transformers. The if. amplifier consists of six stages, V501 through V506 which, together with the associated transformers, provide the required pass band.

(2) The output of fifth if. amplifier V505 is divided to supply a 455-kHz signal to each of three stages: sixth if. amplifier V506, agc amplifier V509, and the cathode follower, one-half of V511. The output signal of the sixth if. amplifier is demodulated in the detector circuit, one-half of V507. An external load may be connected from DIODE LOAD (terminal 14) to ground, with the jumper between terminals 14 and 15 removed. The output of the fifth if. amplifier is amplified in agc amplifier V509, and the resulting signal is rectified by the agc rectifier, one-half of V510. When the FUNCTION switch is set for AGC operation, the gain of rf amplifier V201 and if. amplifiers V501 and V505 is controlled automatically by a dc voltage developed by the agc rectifier, one-half of V510, to keep the output level of the receiver relatively constant and independent of signal strength variation at the antenna. Thus for strong signals, the grid bias is high and the gain of the controlled stages is reduced. The reverse action occurs for weak signals. The response rate of the agc circuits can be controlled to satisfy reception requirements through the use of the AGC switch, the agc time constant circuit, and one-half of tube V511. For MGC operation, the agc bus is grounded by the FUNCTION switch. The cathode follower, one-half of V511, provides a low-impedance connection (50 ohms) from the output of the fifth if. stage, through J514 to the rf detector.

(3) To facilitate operation in the reception of radiotelegraph signals, in certain system applications and in calibration, bfo tube V508 provides a signal in the frequency range from 452 to 458 kHz. This signal is mixed with the 455-kHz if. output signal of the sixth if. amplifier to produce a beat frequency in the output of the detector which is in the audiofrequency (af) range.

(4) The output of the detector (one-half of V507) is coupled to the af amplifier (V602A) through a negative peak limiter (one-half of V507) and a positive peak limiter (one half of V510) which prevents noise peaks from exceeding average signal level. If operation without limiting is desired, the limiters can be disabled by a front panel control.

(5) In addition to supplying signals to the limiter, the detector (one-half of V507) supplies a dc signal to the squelch tube, V606, which is a voltage amplifier. The average dc output voltage of the squelch tube varies in proportion to the average signal level. When the signal level drops below some predetermined noise level established by the setting of the RF GAIN control, and when the FUNCTION switch is set for SQUELCH operation, this voltage operates squelch relay K602. Squelch relay K602 short circuits the output of af amplifier V602B to quiet the receiver output.

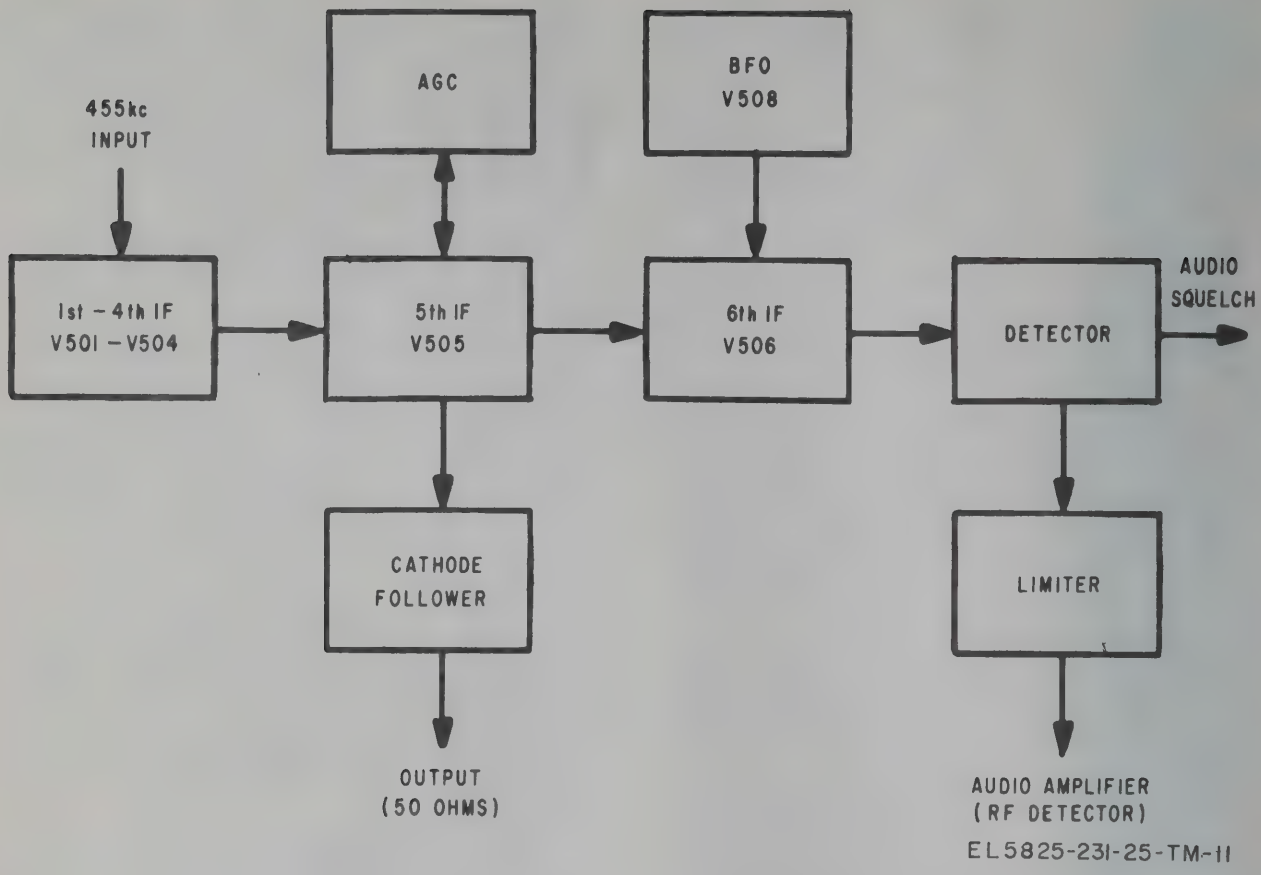


Figure 2–11. If. amplifier, block diagram.

2–9. Detector, Radiofrequency RF–159(*)/TRD

a. Differences in Models. The RF–159/TRD is used in the AN/TRD–23, and the RF–159A/TRD is used in the AN/TRD–23A. The two units are interchangeable and the information in *b* and *c* below applies to both versions. The following circuits have been modified in the RF–159A/TRD (fig. FO–6):

(1) 455-kHz oscillator circuit V1.
(2) Mixer oscillator circuit V6.
(3) Mixer oscillator circuit V11.

b. Block Diagram (fig. 2–12).

(1) The rF detector converts am., fm, pm, or fsk signals from the iF. output of the dF receivers into acceptable form for direction finding display.

(2) The signal from the No. 1 df receiver (455 kHz) passes through the amplifier-limiter stage and mixes with an oscillator to produce a difference frequency of 95 kHz.

(3) The signal from the No. 2 df receiver (or the 455-kHz oscillator in the 1 RCVR mode) passes through the amplifier-limiter stages and mixes with an oscillator to produce a difference frequency of 100 kHz.

(4) The 95-kHz and 100-kHz signals combine in a mixer to produce a 5-kHz signal, free of undesired modulation from the original signal source due to cancellation in the mixer (2 RCVR mode), but containing the desired 90-Hz df modulation.

(5) The 5-kHz output of the mixer is filtered, amplified, limited, and detected to extract the 90-Hz df modulation. This signal is now amplified and filtered, emerging as a 90-Hz sine wave at the output of a cathode follower. The phase of this signal with respect to the goniometer angular position will determine the display on the azimuth indicator.

(6) A rectified version of the df signal is available as an auxiliary output.

c. Stage Analysis (fig. FO–6).

(1) The iF. output of the No. 1 df receiver (455 kHz) is amplified in V7 and then limited in V8, V9, and V10 to remove any aM. that may be present. The output of V10 is applied to the control grid of V11, a pentagrid converter with a crystal controlling its frequency of oscillation to 550 kHz. The plate of this stage is tuned to a difference frequency of 95 kHz.

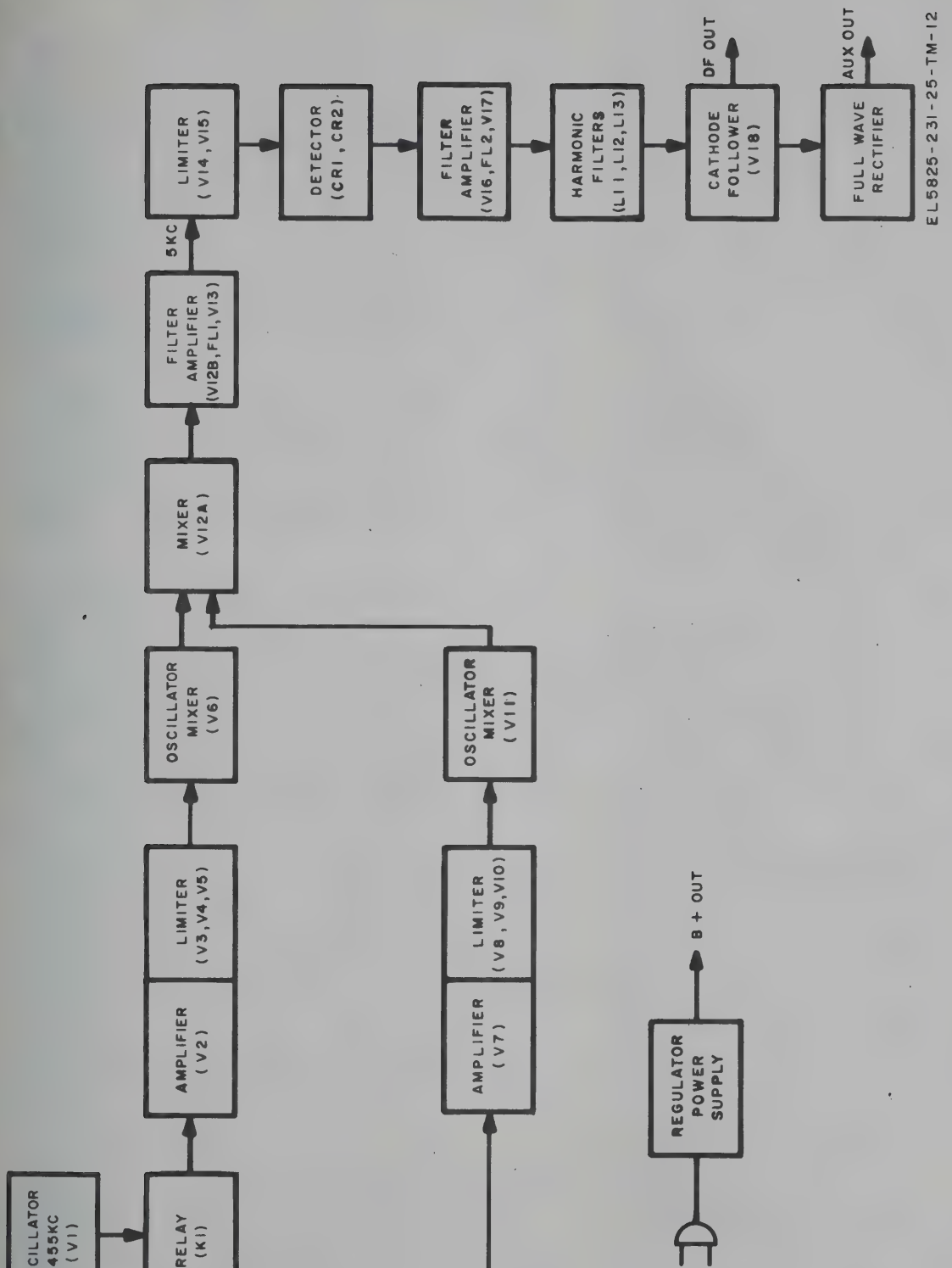


Figure 2-12. Rf detector, block diagram.

(2) The 95-kHz signal derived from V11 is applied to the grid of V12A, mixer section. The cathode of V12A is excited by a signal derived from the No. 2 df receiver channel. This channel has as its source either the iF. of the No. 2 df receiver or the output of crystal oscillator stage V1 as determined by the position of the 1 RCVR-2 RCVR relay.

(3) The signal selected by the 1 RCVR-2 RCVR relay is amplified by V2, limited by V3, V4, V5, and the output of V5 is applied to the control grid of V6, a pentagrid converter tube with a crystal-controlled frequency of 555 kHz.

(4) The plate output of V6 is tuned to the difference frequency of 100 kHz which is applied to the cathode of V12A.

(5) The output of V12A, containing the sum and difference frequencies of the two applied signals, is now impressed on the grid of V12B, the cathode-follower section, and is used to feed FL1 from a low-impedance source. Low-pass filter FL1 selects the 5-kHz signal from the mixer products generated in V12A and the 5-kHz now becomes the operating frequency.

(6) The filtered 5-kHz signal is amplified by V13 and limited in V14 and V15, cathode-coupled limiters, to remove any incidental aM. produced in the previous processing.

(7) The detector (pulse count type), consisting of C72, CR1, CR2, R83, and C74, receives the limited 5-kHz signal and demodulates it, extracting the 90-Hz fm modulation. This is the desired df information.

(8) The resistance-capacitance (rc) networks following the detector reduce the amplitude of the carrier level present with the demodulated signal, and provide a smooth detected wave shape.

(9) The filtered signal is further amplified by V17 and then its second, third, and fourth harmonics further filtered out. Inductors L11, L12, and L13, with their associated capacitors, resistors, and potentiometers, form null networks. When properly adjusted these networks filter out the fourth, thirds, and second harmonics, respectively.

(10) The filtered signal is amplified in V18A. Tube V18 provides a low-impedance output of the 90-Hz df sine wave.

(11) The auxiliary output portion of the circuitry is not used in this system but is described as follows: In parallel with the output is the primary of T2. The secondary of this transformer is resistively center tapped. Diodes CR4 and CR6 form a balanced full-wave rectifier to rectify the balanced-to-ground signal present on the secondary of T2. The rectifier output is connected to an auxiliary output.

2–10. Power Supply PP–4482/TRD

The power supply furnishes regulated B+ and filament voltage to the rf detector. Stage Analysis (fig. FO–3) is as follows:

a. Power of 115 volts Vac, 60 Hz enters the unit through J1. Accessory power is provided at J3 and J4. Rf filtering for the input power is provided by C4 and C5. Power switch S1 controls the input to power transformer T1, which is fused for 2 amperes by primary fuse F1.

b. The secondary of T1 provides high voltage and filament voltage for the full-wave rectifier (V1) and 6.3 volts vac for the filaments of V2, V3, and the rf detector.

c. The output of V1, filtered by C1, is passed through voltage regulator V2. The B+ output is sensed across voltage divider R12, R13, and R14. OUTPUT VOLTAGE control R13 adjusts the grid bias of pentode amplifier V3. The cathode bias of this amplifier is fixed by reference tube V4.

d. A change in the B+ output will be sensed across the voltage divider, changing the grid bias and therefore the plate voltage of the amplifier. The plate voltage, in turn, determines the grid bias of voltage regulator V2, changing its conduction and the B+ output voltage. The operating point for this circuit is determined by the setting of OUTPUT VOLTAGE control R13.

e. Ripple (ac) appearing at the output of filter C1 is tapped off by blocking capacitor C2 and HUM BALANCE control R2. This voltage is impressed on the screen grid of amplifier V3, appearing inverted at the plate. The inverted ripple is applied to the grids of voltage regulator V2 where it cancels the ripple that reaches the cathode.

f. To reduce 60 Hz noise in the rf detector, a small dc voltage is applied to the 6.3-volt ac filaments through voltage divider R15 and R16, and center tap of the filament winding to T1.

2–11. Indicator, Azimuth IP–669/TRD

a. Block Diagram (fig. 2–13).

(1) The azimuth indicator receives the 90-Hz df signal from the rf detector, uses it to modulate the 72-kHz sweep signal and control the blanking circuit, and sends the results to the indicator tube (crt).

(2) The 90-Hz df signal from the rf detector is amplified by the data amplifier and passed to the frequency doubler and blanking circuitry. The frequency doubler output controls the sweep modulator (fig. 2–5).

(3) The sweep signal from the modulator is amplified and passed to the horizontal and vertical deflection plates of the crt. The fixed 90° phase difference between the two secondary windings of the goniometer establishes the proper relationship between the two axes. The amplitude of the sweep signal on the deflection plates determines the amount of deflection.

(4) The envelope of the 72-kHz signal from the goniometer secondaries produces a propeller-shaped pattern on the crt. Because of the frequency doubling of the 90-Hz df signal, two of these patterns are produced for each revolution of the goniometer. The phase relationship between the 72-kHz sweep from the goniometer and the 72-kHz blanking signal determines which half of the propeller pattern actually appears.

(5) The 90 Hz df signal is passed to the sense amplifier in the blanking circuit through a phase-shift network, which shifts the signal 90°. The signal is then clipped and amplified in the sense amplifier, producing a 90-Hz square wave.

(6) The 90-Hz square wave is passed to a phase detector which also receives a 72-kHz signal from the oscillator. The phase detector has a 72-kHz output which reverses phase every time the 90-Hz square wave reverses phase. This output is amplified and passed to the control grid of the crt, where it blanks the tube on negative portion of the 72-kHz blanking signal.

(7) The MONITOR-D.F. switch is in the azimuth indicator. In the MONITOR position, this switch removes the 72-kHz signal input to the modulator and reduces the voltage input to the high-voltage supply, dimming the spot on the crt. The MONITOR-D.F. switch also supplies voltage to energize the MONITOR-D.F. relays in the goniometer drive chassis.

(8) The 1 RCVR-2 RCVR switch also is in the azimuth indicator. In the 2 RCVR (closed) position, the switch completes a circuit which allows the 1 RCVR-2 RCVR relay in the rf detector to energize.

b. Stage Analysis (fig. FO–5).

(1) The 90-Hz df signal enters at J1, passes through D.F. GAIN control R1, and enters data amplifier V1A. The output of V1A passes through cathode follower V1B and is transformer-coupled through T1 to the frequency doubler. The output of the cathode follower is also passed to the sense amplifier through phase-shift network C17, R34 and C18.

(2) The output of the secondary of T1 enters frequency doubler CR1, CR2. This circuit is in effect a full-wave rectifier with an unfiltered output which produces a scallop-shaped waveform of twice the original frequency. BALANCE CONTROL R9 and CUSP BALANCE control R77 are used to adjust the circuit for a symmetrical output for both halves of the 90-Hz input.

(3) The 180-Hz output of the frequency doubler is direct-coupled to the control grid of sweep modulator V2. This tube conducts on the positive peaks of the 180-Hz input, allowing the 72-kHz signal on the signal grid to appear at the plate. When no df signal is present, bias resistors R11 and R12 allow V2 to conduct continuously, providing a constant 72-kHz sweep output. This action creates the circular pattern on the indicator (c, fig. 2–14).

(4) The 72-kHz sweep output of the modulator is coupled through T2 to sweep amplifier V3. The output of the sweep amplifier is coupled through T3 and J2 to J5, the goniometer primary winding. The amplitude and phase of the sweep appearing at the goniometer secondaries is determined by the angular position of the goniometer rotor which couples the energy from primary to secondary (stators). The output of the secondaries is coupled to the crt deflection circuits through T4 and T5. SHAPE control R17 in the horizontal deflection circuit is used to balance the horizontal and vertical deflection circuitry.

(5) Voltage divider R51 through R60 provides bias voltages for the various elements of the crt. INTENSITY control R60 provides bias for the control grid. FOCUS control R57 provides bias for the focusing grid; R48 and R49 are the HORIZONTAL and VERTICAL centering controls.

(6) The 90-Hz df signal output of data amplifier V1 enters the blanking circuit through phase-shift network C17, R34, and C18. This network shifts the 90-Hz sine wave 90° forward. (Note the relationship between waveforms A and F in figure 2–14.) The phase-shifted signal is clipped by diodes CR3 and CR4, and amplified by sense amplifier V6B, producing a squared waveform which is coupled to the phase detector through C19 and T6.

(7) The phase detector reverses the phase of a 72-kHz signal from the oscillator every half-cycle of the 90-Hz square wave from the sense amplifier and passes it to the crt, where it is used for blanking. Diodes CR5 and CR6 conduct on alternate half cycles of the square wave input from T6, allowing the 72-kHz signal entering at the junction of R40 and R41 to pass to blanking amplifier V7. Capacator C22 and transformer T7 produce a 180° phase difference between sig-

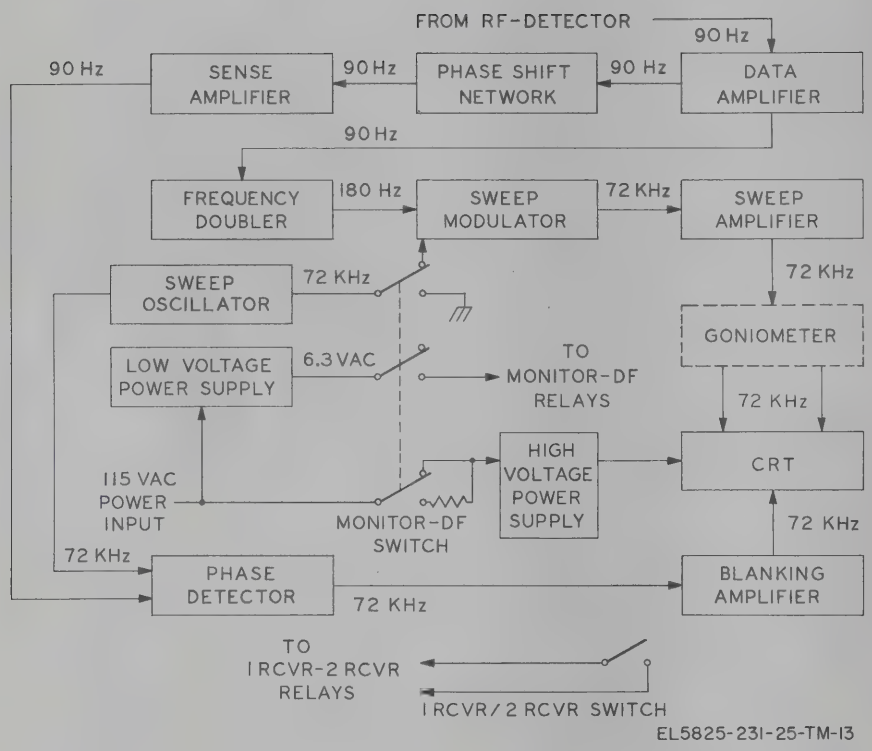


Figure 2–13. Azimuth indicator, block diagram.

nals coupled through CR5 and CR6. This signal is amplified (V7) and coupled through C26 to the crt control grid, where the positive portion is clipped by CR7. The remaining negative portion blanks the indicator. The phase relationship between the 72-kHz blanking signal and the 72-kHz sweep signals to the deflection plates determines which half of the propeller-shaped pattern is blanked. When no df signal is present, no 72-kHz is passed through the blanking circuit, and blanking does not occur.

(8) The 72-kHz sweep signal used in the azimuth indicator is supplied by sweep oscillator circuit V5. This is a crystal-controlled oscillator, with the output passed through cathode follower V6A to the sweep modulator (through SIZE

control R33) and the blanking circuit (through coupling capacitor C21). The 72-kHz input to the sweep modulator is shorted to ground by MONITOR-D.F. switch S3 in the MONITOR mode.

(9) In MONITOR mode, S3 also reduces the 115-volt ac input to the high-voltage power supply of the crt by inserting series resistor R86, and provides 6.3 volts ac at J11 to energize the MONITOR-D.F. relays in the goniometer drive chassis.

(10) The high voltage required by the crt is supplied by conventional voltage doubler CR8 and CR9. The various bias voltages for the crt are tapped off voltage divider R51 through R60, with R57 and R60 functioning as the FOCUS and INTENSITY controls, respectively.

(11) The low-voltage power supply is a full-wave rectifier (V8) with a series voltage regulator. (Refer to paragraph 2–10*b* for a detailed explanation of this circuit.)

2–12. Panel, Power Distribution SB–1747/TRD

a. Block Diagram (fig. 2–15).

(1) Primary input power of 115 or 230 volts ac, 60 Hz may be selected using the LINE INPUT switches.

(2) The control transformer, protected by circuit breakers, provides for the adjustment of the output voltage through the OUTPUT VOLTAGE CONTROL. Meters to monitor the output voltage and line frequency are provided.

b. Stage Analysis (fig. 6–6).

(1) LINE INPUT switches S1 and S2 are ganged. In the 230 VAC position, input line voltage is applied across the full winding of autotransformer T1 through J1. In the 115 VAC position, the line voltage is applied across one half of the transformer winding through J2. The center position of S1 and S2 if OFF.

(2) Various taps on the autotransformer selected by OUTPUT VOLTAGE CONTROL switch S4, provide for adjustment of the output voltage, which is metered by OUTPUT VOLTAGE METER M1. LINE FREQUENCY METER M2 monitors the frequency of the output voltage.

(3) Power is applied to the entire system through LOAD switch S3.

2–13. Monitor Oscilloscope

a. General. The function for oscilloscope 120B used in the AN/TRD–23 follows. For information regarding the AN/USM–318(V)1 oscilloscope used in the AN/TRD–23A, refer to TM 11–6625–1703–15 and chapter 8 of this manual.

b. Block Diagram (fig. 2–16).

(1) The monitor oscilloscope consists of five major functional circuit groups; the vertical amplifier, the sweep generator, the horizontal amplifier, the low-voltage power supply, and the high-voltage power supply.

(2) A vertical input signal is converted into two 180° out-of-phase amplified signals which are applied to the crt for vertical deflection and to the TRIGGER SOURCE switch when in the INT+ and INT positions.

(3) Depending upon the setting of the HORIZONTAL DISPLAY switch, the horizontal or sync input signal is applied to either the TRIGGER SOURCE switch (to be used as the external sync signal), or to the horizontal amplifier (to be used as the external horizontal input signal). Also, 6.3 volts ac is available at the TRIGGER SOURCE switch to provide for a sync signal repetition rate equal to the line frequency.

(4) The sync signal selected by the TRIGGER SOURCE switch is applied to the sweep generator, where the sync signal initiates the horizontal sweep signal and the unblanking gate. The sweep generator applies the sweep signal to the horizontal amplifier and the resultant amplified sweep is applied to the crt as the horizontal deflection signal. The unblanking gate is applied instead of the sweep from the sweep generator. The external sweep is amplified by the horizontal amplifier and applied to the crt intensity control circuits.

c. Stage Analysis (fig. FO–10 through FO–15).

(1) *Vertical amplifier* (fig. FO–12).

(*a*) For ac coupling, capacitor C1 is placed in series with the signal path with the AC-DC switch. The input signal is then applied to VERTICAL SENSITIVITY switch S2. When the switch is in the CAL position, the input is from the calibrator (V4, V5, and associated circuit parts). When the VERTICAL SENSITIVITY switch is in other positions, the input signal is applied to the control grid of amplifier V1A and precision frequency-adjusted attentuators give a 10-to-1 attentuation between adjacent positions.

(*b*) Balanced input to differential amplifier V1B is obtained by removing the ground jumper across resistor R1 (ground strap on front panel) and applying a balanced signal input. Balanced input is useful to amplify simultaneously the out-of-phase (differential) signal and to attentuate the in-phase (common mode) signals, such as hum, noise, etc. This rejection is an inherent property of differential amplifiers. The common-mode signals are attenuated by 40 decibels (db) (100:1), whereas any differential

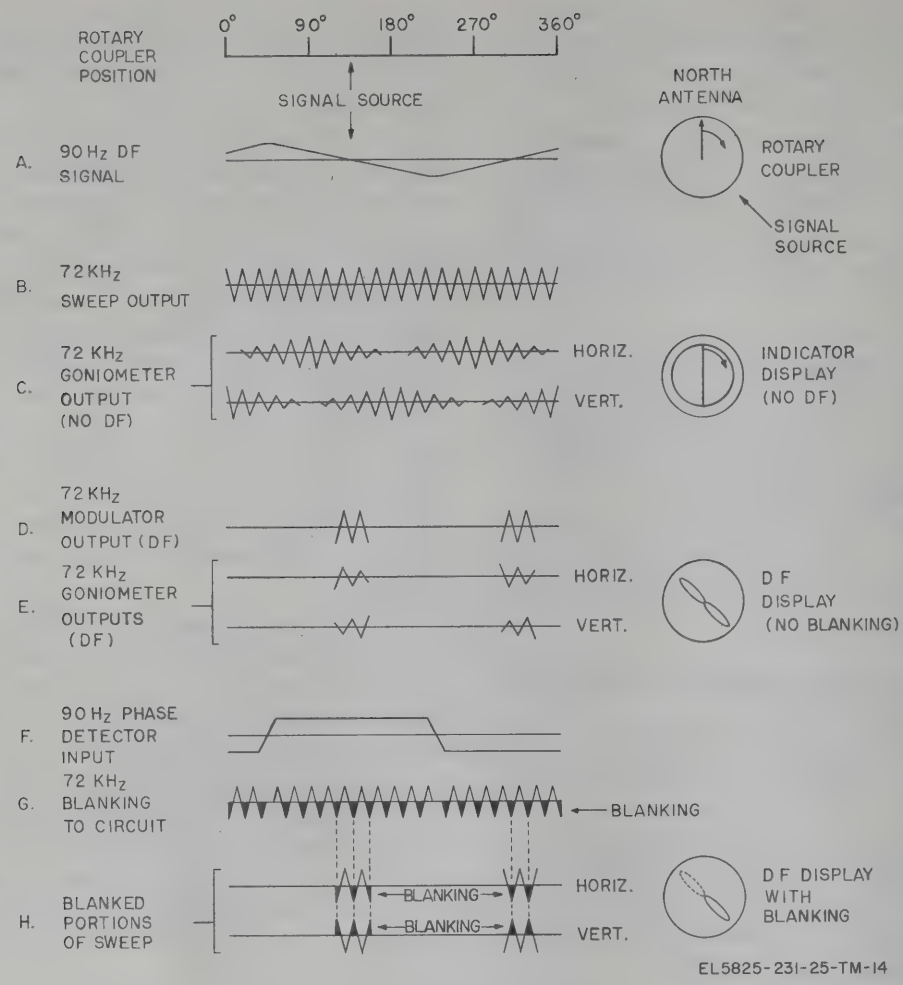


Figure 2–14. Waveforms, azimuth indicator.

input is amplified.

(*c*) The vertical amplifier consists of three sets of balanced differential amplifiers (V1, V2, and V3) in cascade. The three stages are neutralized by plate-to-grid cross neutralization. The first stage, V1, has balance and gain adjustments. The balance adjustment (BAL) control is potentiometer R16 in the cathode circuit, which adjusts the current distribution between the two triodes. VERNIER control potentiometers R21 and CAL potentiometer R20 adjust the resistance between the plates and therefore determine the gain of the amplifier. The VERTICAL VERNIER control provides a 10-to-1 variation in gain between ranges of the VERTICAL SENSITIVITY switch. The second differential amplifier, V2, has VERTICAL POSITION control potentiometer R32 between its cathodes. This potentiometer controls the current distribution between the two triodes and thus determines the vertical position of the crt display. The third differential amplifier, V3, is the output stage. Synchronization signals are taken from the plates of V3 for application to the TRIGGER SOURCE switch. The horizontal sweep circuits trigger only on the negative slope of the signal; therefore, provision is made to take the proper synchronizing signal from either plate of V3.

(*d*) One section of the BEAM FINDER switch is in the cathode circuit of V3. When pressed, the switch increases the common cathode resistance and so reduces the gain of the stage that no amount of unbalance ahead of V3 can deflect the sweep off the crt.

(*e*) The calibrator circuit consists of neon lamps V4, V5, and associated circuit parts. When VERTICAL SENSITIVITY switch S2 is placed at CAL, V4 ionizes and capacitor C14 begins charging. As the voltage across capacitor C14 rises, the voltage at the junction of V4 and R52 rises proportionally. When the voltage at this junction reaches the firing potential of V5, V5 ionizes. Because the conducting potential of V5 is less than the firing potential, the voltage at

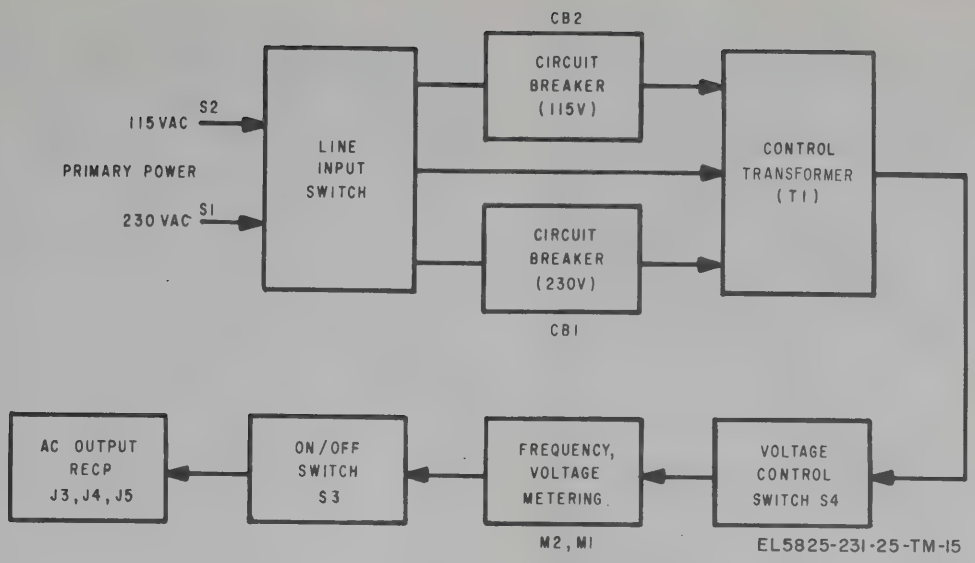


Figure 2–15. Power panel, block diagram.

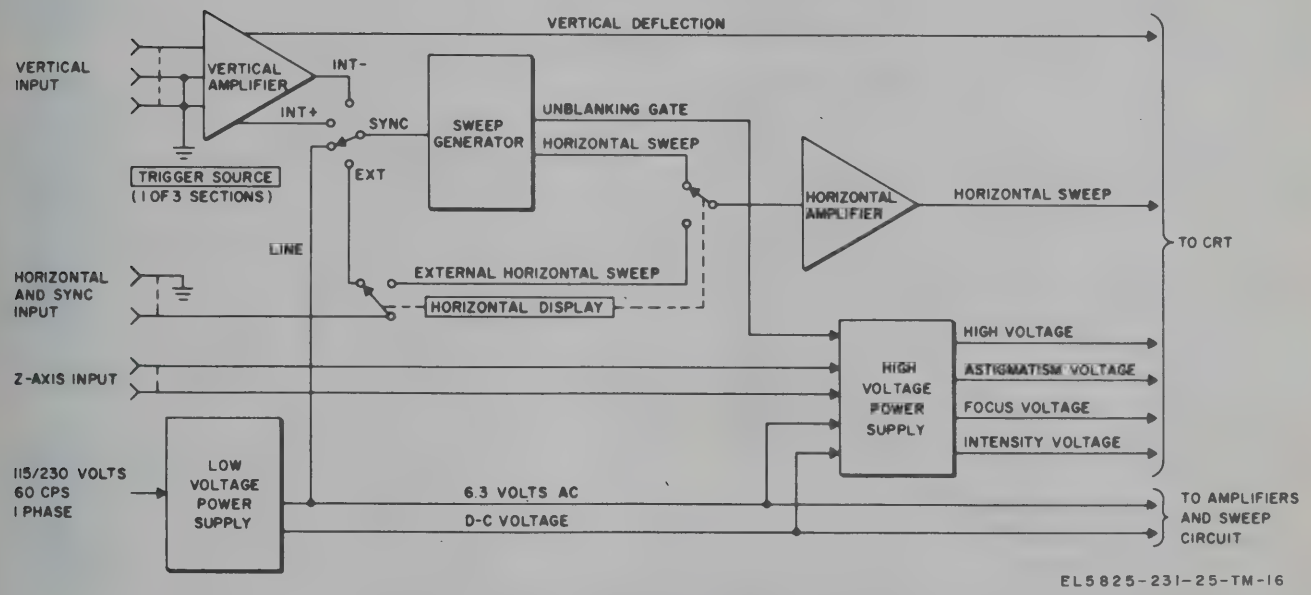


Figure 2–16. Monitor oscilloscope 120B, block diagram.

the junction of V4 and V5 drops, and V4 deionizes. Capacitor C14 discharges through R53, and the potential across V4 increases. When the potential across V4 reaches the firing potential, V4 fires and the voltage at the junction of V4 and V5 drops, deionizing V5. Capacitor C14 starts charging again, and the cycle repeats. A 60-millivolt (mv) square wave is developed across R54, and this signal is applied through the VERTICAL SENSITIVITY switch to the vertical amplifier.

(2) *Sweep generator* (fig. FO–11).

(*a*) The sync signal from the TRIGGER SOURCE switch is applied to trigger generator V201. The trigger generator produces a rectangular wave with a repetition frequency equal to that of the input sync signal. This rectangular wave is applied to a differentiating network L201, R210 which converts it to positive and negative spikes that are coincident with the leading and trailing edges of the rectangular wave. These spikes are then applied to the input of start-stop trigger V202.

(*b*) The negative spike switches the start-stop trigger, which produces two step outputs. The positive-going output is applied through V204 to the high-voltage power supply as the crt unblanking gate, and the negative-going output is applied to switch diode CR201.

(*c*) Switch diode CR201 normally clamps the input to sawtooth generator V205A from generating a sawtooth waveform. When the negative-going step signal from the start-stop trig-

ger is applied to the switch diode, the diode is reverse biased and allows the sawtooth integrator to generate a sawtooth waveform.

(*d*) The sawtooth output of V205B is simultaneously applied to the horizontal amplifier to serve as the horizontal sweep signal and the holdoff cathode follower V203B. The output of the holdoff cathode follower is applied to the input of the start-stop trigger to terminate the sweep. The values of R and C selected by the HORIZONTAL DISPLAY switch determine the slope of the sweep and therefore the time of the sweep. Clamp V203 insures that the sawtooth always starts at the same level.

(*e*) The sync signal selected by the TRIGGER SOURCE switch is applied through capacitor C202 and resistor R201 to the input control grid of V201, which is a Schmitt trigger circuit when the TRIGGER LEVEL control is not in AUTO. The Schmitt trigger is a form of bistable multivibrator, and is used to obtain pulses with rapid risetime and falltime.

(*f*) If initially the input voltage is such that V1 is cut off, V2 conducts. As the input voltage becomes more positive, it eventually reaches a predetermined level at which the circuit changes state; that is, V1 conducts and V2 is cut off. If the input voltage then goes negative, the common cathode potential decreases and the grid of V2 becomes positive. When the input reaches a second predetermined level, V2 conducts and the circuit switches back to its initial state. The output of the circuit is a voltage step, either positive or negative depending upon the slope of the input signal.

(*g*) Trigger generator V201 has some additional features; the TRIGGER LEVEL control adjusts the bias on V201A and thus determines the level which the input trigger must reach to change state; when the TRIGGER LEVEL control is at its extreme limit, switch S202 is placed in AUTO. This opens the shunt across resistor R207 and capacitors C205 and C206 and the trigger generator becomes an astable multivibrator. This action provides triggers to the stop-start trigger even though no sync is applied to the trigger generator. When a sync signal above approximately 50 Hz is applied, the trigger generator then synchronizes with the sync signal. The output of the trigger generator is taken from the plate of V201B and applied to a differentiating network.

(*h*) The differentiating network is composed of the series combination of capacitor C207, inductor L201, and resistor R210. The rc time constant of this network is extremely small compared with the width of the trigger generator output pulses; consequently, the signal developed across inductor L201 and resistor R210 consists of short negative and positive spikes that are coincident with the leading and trailing edges of the trigger output pulses. These spikes are coupled through capacitor C208 to the control grid of V202A, one half of the start-stop trigger.

(*i*) A Schmitt trigger circuit is used as a start-stop trigger. A typical Schmitt trigger is described in (*f*) above. Tube V202 is triggered by a negative spike pulse from the differentiating network. One output waveform is taken from the plate of V202B and simultaneously applied to switch diode CR201 and the grid of clamp V203A. The waveform applied to switch diode CR201 reverse-biases the diode, and thus it ceases conduction. Another output is taken from the plate of V202A and applied through cathode follower V203A to the high-voltage power supply; this serves as the crt unblanking gate.

(*j*) Sawtooth generator V205A is a Miller integrator which produces a linear sawtooth waveform. When switch diode CR201 ceases conduction, the integrating capacitor charges through the integrating resistance, producing a negative-going potential at the control grid of V205A. The amplified signal at the plate of V205A is coupled back through sawtooth cathode follower V205B to the integrating capacitor, completing the negative feedback required by this Miller-type integrator.

(*k*) The sawtooth signal at the cathode of V205B is also applied to SWEEP MAGNIFIER switch S102. When S102 is in the X5 position, the sawtooth applied to the horizontal amplifier has a peak amplitude five times greater than that applied when S102 is in the X1 position; therefore, the angle of slope is increased five times and the sweep time is one-fifth of that selected by the HORIZONTAL DISPLAY switch.

(*l*) The sawtooth signal at the cathode of V203B is applied to the control grid of V202A. When the slope of the signal reaches the upper limit of the start-stop trigger, the trigger changes state; hence, the unblanking gate output of V203A is terminated. Switch diode CR201 and clamp V204 again conduct, respectively, halting the charging of the integrating capacitor and terminating the sawtooth waveform. The holdoff capacitor in the cathode of V203B charges during the rising slope of the signal output of the holdoff cathode follower but does not immediately discharge when the sawtooth input to the holdoff cathode follower terminates. This

action prevents the start-stop trigger from again being triggered by a negative spike until the sweep circuits have fully recovered. A different value of holdoff capacity is selected for each setting of the HORIZONTAL DISPLAY switch.

(3) *Horizontal amplifier* (fig. FO-10).

(*a*) The grid of V101A receives either the sweep output from the horizontal sweep circuits or from an external sweep source, depending on the setting of the HORIZONTAL DISPLAY switch. When external sweep is being used, any one of three horizontal sweep sensitivities can be selected: 0.1, 1.0, or 10.0 volts/cm. The AC-DC switch allows selection of direct coupling, or ac coupling, through capacitor C101.

(*b*) The horizontal amplifier consists of two differential amplifiers (V101 and V102) in cascade. When the HORIZONTAL DISPLAY switch is set for an external sweep input, the resistance between the cathodes of HORIZONTAL VERNIER control R275B in series with the horizontal gain control (R104); otherwise, resistor R107 is between the cathodes. The HORIZONTAL POSITION control (potentiometer R109) between the plates of V101 controls the horizontal position of the crt trace. The second stage (V102) is neutralized by plate-to-grid cross neutralization. The output of the horizontal amplifier is taken from the plates of V102 and applied direct to the horizontal deflection plates of the crt.

(*c*) One section of the BEAM FINDER switch is in the cathode circuit of V102. When pressed, the switch increases the common cathode resistance and so reduces the gain of the stage that no amount of unbalance ahead of V102 can deflect the sweep off the crt.

(4) *Low-voltage power supply* (fig. FO-13).

(*a*) The 115/230-volt, single-phase power is applied through switch S301 to transformer T302. The transformer applies 6.3 volts ac to the vertical amplifier, horizontal amplifier, sweep generator, and high-voltage power supply for use as filament voltage. The transformer applies appropriate ac voltages to the following: the +19-volt dc regulated power supply; the +300, +100-, and +99-volt dc regulated power supply; and the −150-volt dc regulated power supply.

(*b*) The regulated power supplies deliver their dc outputs to the following circuits; +19 volts dc is applied to the horizontal and vertical amplifiers, and +19, +100, +300, and −150 volts ac are applied to the vertical amplifier, the horizontal amplifier, the horizontal sweep circuits, and the high-voltage power supply. The −150-volt supply applies a negative voltage to the +19-, +99-, +100-, and +300-volt supplies for use as a control voltage.

(*c*) The −150-volt supply in the oscilloscope 120B is used as a reference supply for the +300-, +100-, and +99-volt supplies; therefore, any change in the −150-volt supply is reflected as a change in these supply voltages. The ac voltage from T302 is rectified and partially filtered by rectifier CR303 and capacitor C325A. The resulting dc voltage is regulated by tubes V309, V310, and V311.

(*d*) The circuit functions as follows: When power is applied (assuming the −150-volt supply has been adjusted properly), the cathode of V310 becomes fixed at −65 volts and the grid assumes a slightly more negative value. If a line voltage surge or load current change occurs, tending to lower the supply voltage, V310 grid potential changes by half the amount, because the grid is tied to a voltage divider between −150 volts and ground. Bias on V310 increases, lowering its current, raising its plate voltage, which, in turn, lowers the bias on V309. This bias change in V309 lowers its resistance, decreasing the voltage drop across this element which returns the supply voltage to its original value.

(*e*) The +300-volt supply operates almost the same way as the 150-volt supply, except that it uses the −150-volt supply as its voltage reference. In this supply, CR301, CR302, V307, and V308 are the rectifier, services regulator, and amplifier, respectively. The +100- and +99-volt supply is further regulated by V308B, referenced to the +300-volt supply.

(*f*) The +19-volt supply (for the filaments of vertical amplifiers V1 and V2) uses rectifier CR304 and capacitor C328 for rectifier and filter. Transistor Q301 is a series regulator using the potential across Zener diode CR302 for its voltage reference. The current in transistor Q301 determines the value of the dc voltage across the filaments.

(5) *High-voltage power supply* (fig. FO-14).

(*a*) Oscillator V302 generates an ac voltage and applies it to step-up transformer T301. The stepped-up ac voltage is applied to rectifiers V303 and V304. The negative high-voltage output of V303 is applied to the cathode of the crt, and the negative high-voltage output of V304 is applied to the control grid of the crt. The difference between the two voltages is used as crt bias and thus controls the crt intensity.

(*b*) When the INTENSITY & POWER control setting is changed, a change occurs in

the cathode high voltage, causing a change in the voltage level at the wiper of the −2,500-volt adjust potentiometer. This action results in regulator V301 altering the control voltage in a direction necessary to return the cathode high voltage to its original value; however, this now results in the control grid high voltage being higher or lower than was previously and thus the crt intensity is altered.

(*c*) The ac high voltage present in one secondary winding of T301 is rectified by V303 and filtered by capacitor C308. A portion of the +100 volts dc taken from the wiper of INTENSITY & POWER potentiometer R321 is effectively in series with and opposing the high-voltage output of V303. When the BEAM FINDER pushbutton is pressed, the opposing voltage from the wiper of potentiometer R321 is effectively removed and the intensity of the crt trace is increased.

(*d*) When a signal is applied to the Z AXIS input, the signal is applied through capacitor C307 to the cathode of the crt and thus modulates the crt intensity.

(*e*) A voltage-divider network, consisting of resistors R313, R311, R310, R309, R307, potentiometers R312 (FOCUS control) and R308 (−2,500 adjust), is tied between +300 volts dc and the cathode of the crt. The voltage present at the wiper of R312 is applied to the crt focusing grid as focusing voltage, and the voltage present at the wiper of R308 is applied to amplifier V301B as the high-voltage control voltage.

(*f*) When a change in the value of high voltage occurs, a corresponding change occurs at the wiper of potentiometer R308. This action alters the bias at the grid of V301B, and the resultant change in the plate voltage is dc coupled through R305 to the control grid of V301A. This, in turn, results in a change in the plate voltage of V301A, which is connected to the screen grid of oscillator V302. The overall effect is that when the high voltage decreases, the screen grid voltage of V302 increases to a point where the increased ac output of V302 restores the high voltage to its original value.

(*g*) The ac high voltage across the other secondary of transformer T301 is rectified by V304 and filtered by capacitor C310. The negative side of the high voltage is applied through resistor R327 to the control grid of the crt. The positive side of the high voltage is applied through resistor R326 to the horizontal sweep circuits, where the unblanking gate is generated. When the positive-going unblanking gate is generated, the crt control grid bias becomes less negative and the crt is unblanked.

2–14. Transmitter, Radio T–279A/UR

a. Block Diagram (fig. 2–17).

(1) The target transmitter is a low-powered, amplitude-modulated or continuous-wave transmitter with a frequency range from 0.50 to 30 MHz. The transmitter is comprised of four major functioning circuits; the rf oscillator, the rf amplifier, the if. oscillator, and the relaxation oscillator. The transmitter is battery powered.

(2) The output frequency of the Hartley type rf oscillator is determined by a resonant circuit. The particular frequency range desired is obtained by selecting the proper inductance, and the frequency within this range is selected by rotating a variable capacitor.

(3) The rf amplifier amplifies and isolates the rf oscillator from the antenna circuit, preventing variations in output capacitance from affecting the oscillator frequency.

(4) The af oscillator produces an audio-frequency voltage which is applied to the grid of the rf amplifier when an amplitude-modulated signal is desired.

(5) The neon panel lamp in the relaxation oscillator circuit flashes intermittently (about once every 2 seconds) to indicate that the transmitter is on and that the relaxation circuit is producing an audible *tick* on the transmitted signal for identification purposes.

(6) The power supply for the transformer consists of one 1.5-volt Battery BA–404/U and one 135-volt Battery BA–424/U.

b. Stage Analysis (fig. 6–7).

(1) *Rf oscillator V601.*

(*a*) The rf oscillator stage uses a triode-connected 3A5 tube in a series fed Hartley oscillator circuit is designed to operate on any frequency within the range from 0.5 to 30 MHz. This range is divided into six bands, any one of which may be selected by BANDSWITCH S603. BANDSWITCH S603 connects one of six tapped coils (L601 to L606) into the oscillator-tuned circuit. Trimmer capacitor C602 varies the capacitance of the oscillator-tuned circuit and thus the frequency so that it will *track* correctly with the rf amplifier stage.

(*b*) The circuit does not permit grounding either end of the coils; therefore, switch sections 2 and 3, must be used. Each switch section has a shorting bar which places all but the active coil at ac ground (but at +90 volts dc) to minimize energy absorption by the unused coils.

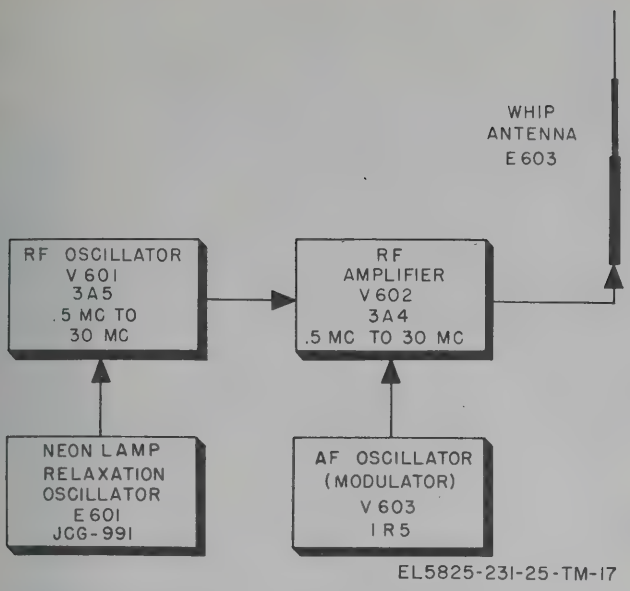


Figure 2–17. Target transmitter, block diagram.

(*c*) The circuit oscillates because a voltage 180° out of phase with the plate voltage is obtained from the grid end of the tuned circuit. This voltage, which is of the proper phase and magnitude to sustain oscillation, is fed back to the grid through capacitor C603. Grid current flowing on positive alternations charges C603 through the low grid-to-cathode resistance of V601. Only a small portion of this charge is allowed to leak off on negative alternations because R601 presents a relatively large discharge path. After several cycles, a residual charge is accumulated on C603 which is effectively a negative bias between the grid and the cathode. Capacitors C604 and C615 and coil L613 form a decoupling filter at the oscillator frequency and isolate this stage from the B+ supply to prevent interaction with other circuits. Capacitor C607 couples the rf oscillator output to rf amplifier V602.

(2) *Rf amplifier V602.*

(*a*) The rf amplifier stage amplifies the signal and isolates the rf oscillator from the antenna. The rf amplifiers, acting as buffer prevent changes in the antenna capacitance (caused by the operator's movements) from being reflected directly back into the tank circuit of the oscillator stage and causing a frequency shift. Thus, the oscillator frequency is more stable and less susceptible to outside influences.

(*b*) The signal from the rf oscillator is coupled into the grid circuit through C607. The modulating audio signal is applied to the grid circuit across R606.

(*c*) This stage uses tube 3A4 in a class C amplifier circuit. The plate voltage, and hence the radiated signal strength, is controlled by OUTPUT control R609. Resistor R612 is in series with resistor R609 to limit the current if the stage become detuned. The six coils in this stage have inductances that are similar to those in the rf oscillator. These coils are not tapped, and one end of each is grounded through bypass capacitors C613 and C617. Thus, only one switch section of S603 (section 1) is required by this stage. Unused coils in this stage also are shorted to prevent energy absorption. Tuning capacitor C612 is ganged to oscillator tuning capacitor C601 so that only one tuning control is required.

(*d*) On positive alternations of the input signal from V601, grid current flows through V602; therefore, the low grid-to-cathode resistance of the tube charges capacitor C607 negatively on the V602 grid side. On negative alternations of the signal from V601, only a small portion of the negative charge on C607 can leak off through the high resistance of V602 grid resistors R605 and R606. After several cycles of the signal from V601, C607 acquires an average negative charge which is effectively a negative bias between grid and cathode of V602. This is commonly known as grid leak bias. The output of V602 is coupled to the antenna through capacitor C611. Resistor R608 is the screendropping resistor and C610 is the screen bypass capacitor.

(3) *Af oscillator V603.*

(*a*) The audiofrequency oscillator has tube 1R5 in a circuit which uses the negative resistance characteristic of the signal grid (grid 3) to maintain the oscillations. In a conventional oscillator, it is expected that an increase in control grid potential will cause a corresponding increase in plate or anode current. In negative resistance oscillator circuits, this concept does not follow. Capacitor C614 may be regarded as the key element of the circuit. In the absence of C614 a decrease in grid 2 (pin 3) voltage would result in a corresponding decrease in grid 2 current. However, with C614 in the circuit, the negative-going grid 2 voltage is coupled to grid 3. The coincident drop in grid 3 (pin 6) voltage feeds back toward grid 2 a great number of electrons emitted from the cathode that would otherwise have continued to the plate. This action results in a net increase in grid 2 current until the potential at grid 2 reaches the point where no further increase in the attraction of electrons is possible. A positive-going voltage on grid 3 reverses the process. The fre-

quency of oscillation approximately 800 cycles) is determined by the time constant of capacitor C614 and resistor R613. The output of the rf amplifier couples through C609. Capacitor C608 and resistor R607 constitute a decoupling network to prevent rf from affecting the tube operation. Resistor R612 is the screen-grid resistor.

(*b*) The audiofrequency signal thus applied to the grid of the rf amplifier stage effectively increases and decreases the grid bias on the stage at an audiofrequency rate. Varying the grid bias varies the power output, and because the power output is varying at an audiofrequency rate, the rf carrier is amplitude modulated. The signal may be easily identified at the receiver by turning MCW-CW switch S602 to MCW.

(4) *Neon lamp relaxation oscillator E601.*

(*a*) The neon lamp (NE–16), in conjunction with capacitor C606 and resistor R604, forms a relaxation oscillator. Voltage across the lamp and C606 builds up slowly until the neon gas ignites (approximately 75 volts). The lamp then appears as a low resistance and discharge C606. When the voltage across the capacitor drops to approximately 60 volts, the lamp is extinguished and its resistance rises to a high value, thereby allowing the voltage to build up on C607 and the lamp to repeat the cycle.

(*b*) The bulb flashes approximately every 2 seconds, indicating that the set is turned on. Each time the bulb flashes, a voltage pulse is applied to the grid of the rf oscillator tube through coupling capacitor C605. This superimposes an audible *tick* on the rf carrier, which is a further aid in identifying the target transmitter signal at the receiver. Resistor R602 and capacitor C616 form an rf decoupling network, isolating the relaxation oscillator from the rf grid voltage on V601. The *tick* may be heard whether af oscillator V603 is on or off (switch S602 on MCW or CW).

or unswitched binaural monitoring of two receivers simultaneously.

(2) An input for keying either one of two transmitters is also provided in each box.

2–15. Distribution Boxes, Audio

a. General.

The AN/TRD–23 and AN/TRD–23A are electrically identical and perform similar functions. They are not, however, mechanically interchangeable. These units use three audio boxes:

Console	*AN/TRD–23*	*AN/TRD–23A*
Primary	J–2674/TRD	J–2871/TRD–23A
Secondary	J–2674/TRD	J–2871/TRD–23A
Communications	J–2679/TRD	J–2872/TRD–23A

b. Transmitter Control and Audio Switching (fig. FO–20).

(1) The audio boxes provide for switched monaural monitoring of the df or net receivers,

Section III. INTERUNIT CIRCUIT DETAILS

2–16. Equipment Consoles

a. Models. Direction Finder Sets AN/TRD–23(–) use three equipment consoles:

Console	*AN/TRD–23*	*AN/TRD–23A*
Primary	CY–4873/TRD	CY–6671/TRD
Secondary	CY–4873/TRD	CY–6690/TRD
Communication	CY–6023/G	CY–6023A/G

b. Equipment Location. Figure 2–18 shows the location of the various units in the three consoles. In addition to the units shown, each console contains ac power strips which furnish power for all the units in the console. The ac power strips are controlled by the power panel in the secondary console (para 2–20*b*).

c. Distinguishing Characteristics.

(1) The primary console contains the antenna input panel on which all connections to the antenna systems are made.

(2) The secondary console controls the power for all three consoles through the power panel.

(3) The communications console contains a separate Loudspeaker Assembly LS–585/TRD–23A which provides two loudspeakers for simultaneous monitoring of both net receivers.

2–17. Shelter S–280(*)/G

a. General. The shelter has both heating and air-conditioning facilities. Two 9,000 British thermal units (btu) air-conditioners are supplied (TM 5–4620–228–15) for cooling and one 15,000 Btu heater. A safe and various accessories are also provided. The AN/TRD–23A shelter (S–280A/G) has the following changes in equipment location:

(1) The communications console light is mounted on the ceiling.

(2) The accessories storage case is mounted on the floor beside the secondary console.

(3) The thermostat is located above the exhaust fan switch and plug.

(4) A flashlight is mounted below the exhaust fan.

(5) A line filter has been added between the power input panel and the main power switch.

(6) The gasoline hose is mounted on three

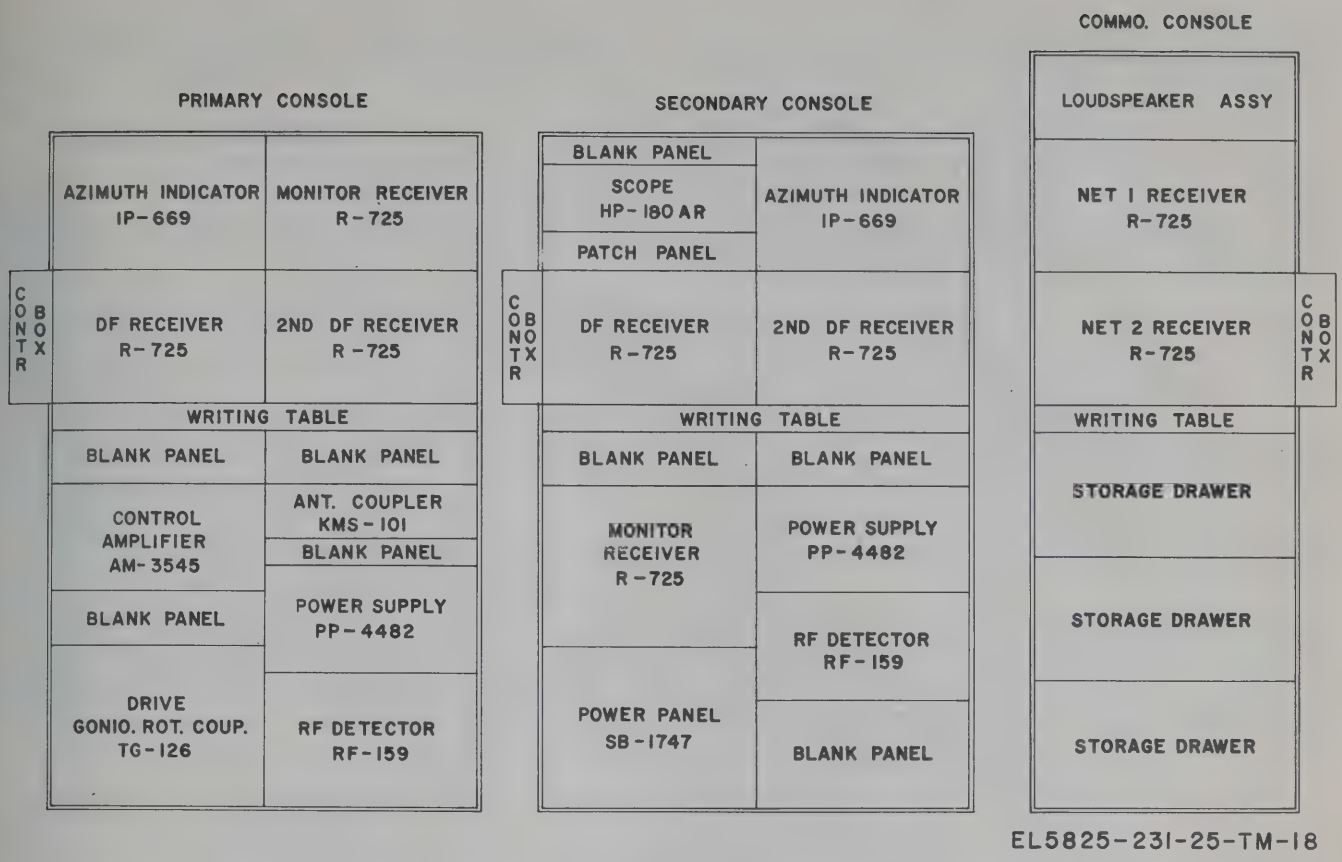


Figure 2–18. Direction Finder Set AN/TRD–23(*), location of components in consoles.

wall brackets.

(7) Air-conditioner aperture covers are stored behind the communicator console.

b. Shelter Power (fig. 2–20 and FO–18).

(1) All power enters the shelter through the power input connector line input filter, master safety switch and circuit breaker panel. A 115-volt, 60-Hz, single-phase or three-phase source may be used.

(2) Lighting can be controlled by a BLACKOUT switch, which shuts off power to all lights, or individual switches and dimmers on each light. Power for lighting comes through the No. 2 circuit breaker. A BLACKOUT BY-PASS switch is also provided.

(3) Console power is provided to the power panel in the secondary console through the console power connector and the No. 5 circuit breaker.

(4) The air-conditioners, heater, and exhaust fan circuits are protected by individual circuit breakers. The accessory ac receptacles are similarly protected.

2–18. Operational Control Circuits

a. MONITOR-D.F. Switch (fig. 2–19).

(1) In the MONITOR position, the MONITOR-D.F. switches (located on the azimuth indicator front panels) energize relays in the goniometer drive chassis by applying 6.3 volts ac to rectifiers.

(2) When energized, each relay disconnects a No. 1 df receiver from the rotary coupler, connects a dummy load to the No. 1 df receiver balanced input, and connects one of the antenna coupler outputs to the No. 1 df receiver unbalanced input.

(3) In the D.F. mode (deenergized), these relays reverse the conditions above, and connect dummy loads to the unbalanced inputs of the No. 1 df receivers.

(4) MONITOR-D.F. switch S3 also inserts series resistor R86 in the high-voltage power supply primary in the azimuth indicator (fig. 2–13). This action reduces the high voltage to the crt enough to remove this visible trace.

b. 1 RCVR-2 RCVR Switch.

(1) The 1 RCVR-2 RCVR switch S2, located on the front panel of the azimuth indicator, energizes relay K1 in the rf detector in the 2 RCVR mode.

(2) When K1 is energized (fig. 6–18), B+ is removed from the 455-kHz oscillator V1 in the rf detector, and the if. output of the No. 2 df

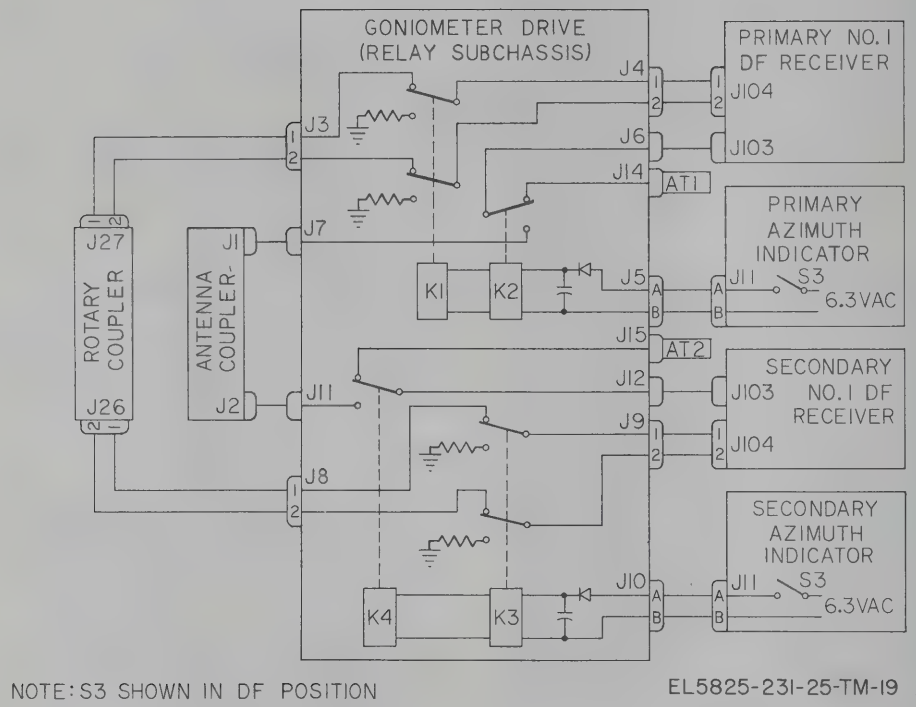


Figure 2–19. MONITOR-D.F. switch, interunit diagram.

receiver is connected to rf detector input amplifier V2.

(3) In the 1 RCVR mode, K1 is deenergized, oscillator V1 receives B+, and the if. of the No. 2 df receiver is disconnected from the input amplifier and grounded.

2–19. Signal Voltage Distribution

(fig. 2–4 and FO–19)

a. Rf Signals (1.5 to 20 MHz).

(1) Signals intercepted by the antenna system enter through the antenna input panel in the primary console. The monitor antenna signal is routed to the antenna coupler, and the df antenna signal connects to the rotary coupler.

(2) The output of the rotary coupler is connected to the No. 1 df receiver inputs through the MONITOR-D.F. relays (para 2–18).

(3) The antenna coupler output connects to the monitor, net, and No. 2 df receivers. Two of

its outputs go to the No. 1 df receivers through the MONITOR-D.F. relays in the MONITOR mode.

b. If. Signals (455 kHz).

(1) The if. outputs from J116 of the No. 1 df receiver and the No. 2 df receiver (in the 2 RCVR mode) go to the rf detector at J4 in each console.

(2) The monitor oscilloscope also receives the secondary No. 1 df receiver if. output through J5 on the secondary rf detector and J29 on the monitor panel.

c. Df Signals (90 Hz). The detected 90-Hz df signals leave the rf detectors at J6 and enter the azimuth indicators at J1.

d. Sweep Signals (72 kHz).

(1) The 72-kHz sweep signals leave the azimuth indicator at J2 and go to J5 of the primary and secondary goniometers.

(2) The sweep is processed by the goniometers and leaves at J1, J2, J3, and J4 to re-enter the azimuth indicators at J3, J4, J5, and J6.

e. Sync Voltage. Synchronizing voltage for the monitor oscilloscope leaves the goniometer drive unit at J1 and is supplied to the oscilloscope through J30 on the monitor panel.

f. Drive Motor Voltage (180 Hz). The goniometer drive motor receives its drive voltage at J13 on the goniometer drive chassis. This voltage is supplied from J2 on the control amplifier.

2–20. Power Distribution

a. Shelter Power (fig. 2–20 and FO–18). For shelter power, refer to paragraph 2–17*b*.

b. Console Power (fig. FO–18).

(1) Console power enters the power panel in the secondary console at J2. All units in the secondary console receiver power from the ac power strips which connect to the power panel at J4.

(2) Units in the primary and communications consoles receive power from their respective ac power strips. These strips are connected, through wall outlets, to the power panel at J3.

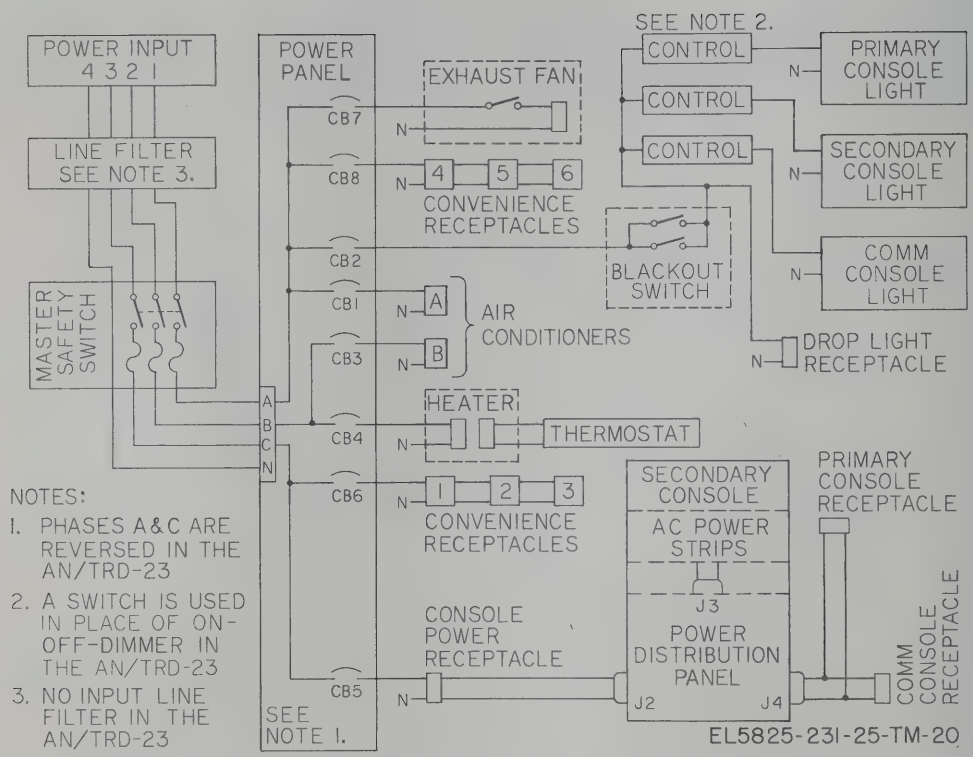


Figure 2-20. AN/TRD-23(*), power distribution.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. GENERAL

3-1. Scope of Organizational Maintenance

a. This chapter contains instructions covering organizational maintenance for Direction Finder Sets AN/TRD-23(*). It includes instructions for performing preventive and periodic maintenance, and troubleshooting functions to be performed by the organizational repairman.

b. Organizational maintenance of the direction finder set includes:

(1) Preventive maintenance (para 3-3 through 3-6).

(2) Troubleshooting (para 3-7 through 3-9).

(3) Repair and adjustment (para 3-10).

3-2. Tools and Test Equipment

The tools and test equipment required to perform organizational maintenance on the AN/TRD-23(*) are:

Federal stock No.	*Equipment*	*References*
6625-376-4939	Test Set, Electron Tube TV-7A/U	TM 11-6625-274-12
5180-856-1578	Tool Kit, Radio Repairman TK-115/U	
6625-553-0142	Multimeter TS-352B/U	TM 11-6625-366-15
NSN	Probe, Test MX-8385/U	

Section II. PREVENTIVE MAINTENANCE

3-3. General

a. Preventive maintenance is the systematic care, inspection and servicing of equipment to assure maximum operational capability. Preventive maintenance checks and services of the AN/TRD-23(*) at organizational category are made at monthly and quarterly intervals unless otherwise directed by the commanding officer.

b. Maintenance forms and records to be used and maintained on this equipment are specified in TM 38-750.

c. Monthly maintenance consists of the following:

(1) Perform the maintenance functions indicated in the monthly preventive maintenance checks and services chart (para 3-4).

(2) Adjustment of the maintenance intervals must be made to compensate for unusual operating conditions.

(3) Equipment in limited storage does not require monthly preventive maintenance.

d. Quarterly maintenance consists of the following:

(1) Perform the checks and services listed in paragraph 3-5 quarterly.

(2) Monthly maintenance services constitute a part of the quarterly maintenance and must be performed concurrently.

3-4. Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	*Item to be inspected*	*Procedure*	*References*
1	Cabinet interiors	Open rear doors of all consoles and check interiors for water leakage condensation and corrosion.	
2	Electron tubes	Check electron tubes for loose envelopes, cap connectors, cracked sockets, insufficient socket spring tension.	
3	Oil-filled capacitors (CP type with metal case).	Check for leaks, bulges, and discoloration.	

Sequence No.	Item to be inspected	Procedure	References
4	Variable capacitor	Check for dirt, moisture, misalignment of plates, and loose mountings.	Para 4–7, TM 11–5825–231–10.
5	Resistors	Check bushings and insulators for cracks, chips, blistering, discoloration, and moisture.	
6	Capacitor and resistor terminals.	Check for corrosion, dirt, and loose contacts.	Para 4–7, TM 11–5825–231–10.
7	Wafer switches	Check contacts for dirt or corrosion	Para 4–7, TM 11–5825–231–10.
8	Terminal block	Check for loose connections, cracks, and breaks.	
9	Transformers, choke, potentiometer, and rheostats.	Check connection, mounting hardware, and components for signs of overheating.	
10	Azimuth indicators	Check for burn spot on cathode-ray tubes.	
11	Receivers	Check the receivers in accordance with procedures in the maintenance manual.	TM 11–5825–358–20.
12	Target transmitter	Turn transmitter on. Check for flashing of indicator lamp.	

3–5. Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Completeness	See that the equipment is complete	Para 1–6, TM 11–5825–231–10.
2	Installation	See that equipment is properly installed.	Para 2–6, TM 11–5825–231–10.
3	Cleanliness	See that equipment is clean	Para 4–7, TM 11–5825–231–10.
4	Preservation	Check all surfaces for evidence of fungus. Remove rust and corrosion and spot-paint bare spots.	Para 4–7 and 5–10, TM 11–5825–231–10.
5	Publications	See that all publications are complete, serviceable, and current.	DA Pam 310–4.
6	Modifications	Determine if new applicable MWO's have been published. ALL URGENT MWO's must be applied immediately. ALL NORMAL MWO's must be scheduled.	DA Pam 310–7.
7	Gaskets	Check gaskets for moisture, oil saturation, and brittle, brown, cracked, loose, pinched, or mismatched sections.	
8	Pluckout items	Inspect clamps and seating of pluckout items. Check for wrong, bent, or broken parts.	
9	Fuses	See that all operating fuses are of the correct value. Check spare fuses for proper value and quantity.	Para 4–10, TM 11–5825–231–10.
10	Mounting	See that all bolts, nuts, and washers are correctly positioned and properly tightened. Check for cracked, bent, or broken brackets.	
11	Connections	Check to be sure that plugs and sockets are clean, intact, and not loose-fitting.	Para 4–7, TM 11–5825–231–10.
12	Knobs, dials, and switches	While making the operating checks, observe that the mechanical action of each knob, dial, and	

Sequence No.	Item to be inspected	Procedure	References
		switch is smooth and free of external or internal binding.	
13	Receivers	Check the receivers in accordance with the preventive maintenance checks and services chart.	TM 11–5825–358–20.

3–6. Lubrication

No periodic lubrication is required for Direction Finder Set AN/TRD–23(*). All required lubrication has been performed at the factory and is sufficient for the life of the equipment.

Section III. ORGANIZATIONAL TROUBLESHOOTING PROCEDURES

3–7. Scope of Troubleshooting

a. The troubleshooting and repair work which can be performed at organizational maintenance is necessarily limited in scope by the tools, test equipment, and replaceable parts available. Accordingly, the procedures in this section require only equipment which has been listed in paragraph 3–2.

b. The troubleshooting procedures which follow provide for isolation of a malfunction to a unit and of corrective measures to be taken. If the corrective measures described do not correct the malfunction, the defective unit should be replaced and returned to a repair facility.

3–8. Visual Inspection

a. General. Failures in electronic equipment may often be caused by one or more of the following items.

(1) Improperly connected, disconnected, or broken cables.

(2) All pilot lamps on. Replace defective lamps.

(3) All units receiving power. Check tubes or pilot lamps.

b. Azimuth Indicator Control Settings.

(1) MONITOR-D.F. switch in D.F. position.

(2) 1 RCVR-2 RCVR switch in 1 RCVR position.

(3) D.F. GAIN control not fully counterclockwise (ccw).

(4) INTENSITY control not fully ccw.

c. Meter Indications.

Unit	Meter	Normal indication
Antenna coupler	TEST Meter:	
	A1Q1 & A1Q2	40 to 56
	A2Q1 & A2Q2	36 to 53
	B+	48 to 54
	BIAS	40 to 56
Power panel	OUTPUT VOLTAGE	115 volts
	LINE FREQUENCY	60 Hz

3–9. Interunit Troubleshooting

a. General. Interunit troubleshooting for the AN/TRD–23(*) is divided into two main sections:

(1) Trouble common to both consoles.

(2) Trouble confined to one console.

b. Trouble Common to Both Consoles. When the same trouble is observed on both consoles, the difficulty probably lies in one of the units common to both consoles. These units should be checked first when system-wide difficulties occur. Also, refer to the troubleshooting chart. Units common to both consoles are:

(1) Antenna coupler.

(2) Goniometer drive.

(3) Control amplifier.

(4) Power panel.

c. Trouble Confined to One Console. When abnormal operation is experienced in one console only, substitution of units from the operating console is often useful in identifying the defective unit. Refer to the troubleshooting chart for more specific checks.

d. Troubleshooting Chart. The following chart gives a series of checks which will isolate a malfunction to a unit. When a check fails, replace the unit under test.

Chart 3–1. Interunit Troubleshooting

Item	Malfunction	Probable cause	Corrective action
1	No display on both consoles	*a.* Goniometer drive	*a.* Sync pulse output on monitor scope.
		b. Control amplifier	*b.* Indicator lamp on front panel of control amplifier.
		c. Rotary coupler	*c.* If. output on monitor scope.
		d. Power panel	*d.* Check panel meters.

Item	Malfunction	Probable cause	Corrective action
2	No display on one console	*a.* Azimuth indicator MONITOR-D.F. switch in wrong position.	*a.* Check MONITOR-D.F. switch.
		b. Receiver	*b.* Check control settings and if. output on monitor scope.
		c. Rf. detector	*c.* With scope probe connected between monitor scope and J6 on the rf detector, observe 90-Hz signal.
		d. Power supply	*d.* Check FILAMENT indicator lamp and reference tube V4 for glow.
		e. Azimuth indicator	*e.* Reduce D.F. GAIN and observe circular display. Check control settings.
		f. Goniometer	*f.* Switch cables between two goniometers.
3	No monitor receiver on all receivers.	Antenna coupler	Check TEST METER readings.
4	No pattern or dot	*a.* Azimuth indicator INTENSITY control.	*a.* Check INTENSITY control setting.
		b. Fuse	*b.* Check fuses F101, F102, and F103.
5	Dot only	*a.* Defective sweep oscillator in azimuth indicator.	*a.* With the scope probe connected to the monitor oscilloscope, observe the 72-kHz sweep signal at J2 on the azimuth indicator.
		b. Defective goniometer	*b.* Substitute other goniometer by switching interconnecting cable.
6	Straight line	Defective goniometer	See 5*b* above.
7	Full propeller pattern	Defective blanking circuit in azimuth indicator.	Adjust T7 on azimuth indicator.
8	Erratic bearing indication	*a.* Receiver gain low	*a.* Check RF GAIN control setting.
		b. Weak signal	*b.* Check receiver CARRIER LEVEL meter.
		c. Interfering modulation	*c.* Try 2 RCVR mode.
		d. Receiver gain low	*d.* Substitute another receiver by switching interconnecting cabling.

3–10. Repair and Replacement

a. General. Organizational repair is limited to replacement of defective parts available in the spare parts supplied with the direction finder set. A list of these spare parts is provided in TM 11–5825–231–10. Specific instructions for the replacement of some items follows:

b. Removal of Goniometers. The primary and secondary goniometers are mounted identically so that the removal procedure applies to both.

(1) Loosen the two Allen head setscrews on the flexible goniometer drive coupling which secure the coupling to the goniometer shaft. A hole in the top of the drive housing provides access to the coupling setscrews.

(2) Remove the two hexagonal-head bolts which secure the goniometer mounting plate to the drive housing.

(3) Pull the goniometer forward slowly, to release the shaft from the coupling without flexing it.

c. Replacement of Goniometers. The primary and secondary goniometers are replaced as follows:

(1) Align goniometer shaft with coupling in the drive housing. Do not force alignment; the flexible coupling may be damaged.

(2) Engage the goniometer assembly with the coupling in the drive housing until the mounting plate is flush with the housing, and bolt-holes are aligned with slotted holes in mounting plate.

(3) Insert and tighten the two hexagonal head mounting bolts.

(4) Tighten the two Allen head setscrews on the shaft coupling, accessible through the top hole in the drive housing.

d. Removal and Replacement of Timing Belt.

(1) Remove goniometers (*b* above).

(2) Loosen setscrews (14, fig. 6–1 and 21, fig. 6–2) on both goniometer flexible shaft couplers and remove couplers.

(3) Loosen setscrews (19, fig. 6–1) on timing belt pulley in secondary goniometer drive housing and remove pulley from shaft.

(4) Refer to figure 6–2 and remove timing belt (19) from pulley timing belt (18) through primary goniometer drive housing (16) access holes. Replace with new timing belt.

(5) Place new timing belt pulley (20, fig. 6–1) in secondary goniometer drive housing (22) and replace pulley on sync assembly shaft (31).

(6) Loosen four bolts from mounting hole (23) accessible from bottom of chassis.

(7) Set belt tension by adjusting position of secondary goniometer drive housing (22) on drive mounting plate (18) so top and bottom loops of belt are parallel with each other and to mounting plate (no sagging). If belt is too loose, it will cause vibration and if it is too tight, motor B1 will not operate at proper sync speed.

(8) When proper tension on timing belt is attained, retighten four mounting bolts of secondary goniometer drive housing from bottom of chassis.

(9) Replace goniometers (*c* above).

CHAPTER 4

DS AND GS MAINTENANCE AND FINAL TESTING FOR AN/TRD–23(*)

Section I. GENERAL

4–1. Scope of Maintenance Instructions (AN/TRD–23(*))

The maintenance procedures in this chapter supplement the procedures in the organizational maintenance instructions (ch 3). The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at organizational category, is carried to a higher category in this chapter. Sectionalization, localizing, and isolating techniques used in the troubleshooting procedures are more advanced. Section II provides bench troubleshooting procedures; section III describes repairs and parts replacement techniques; section IV details adjustment and alignment procedures for each unit.

4–2. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective direction finder set is to sectionalize the fault. Sectionalization means tracing the fault to a major functional unit. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, high-leakage capacitors, arcing and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be isolated by checking voltages and resistances.

b. Sectionalization. The two tests listed below are designed to reduce unnecessary work, and to aid in tracing trouble in a defective direction finder set. The AN/TRD–23(*) consists of the following major sections or units: antenna system, antenna coupler, goniometer drive, control amplifier, receivers, rf detector, power supply, azimuth indicator, power panel, and target transmitter. The first step is to locate the section or unit at fault by the following methods:

(1) *Visual inspection tests.* The purpose of visual inspection is to locate faults without testing or measuring circuits. Meter readings, scope patterns (holes or peaks), and other visual signs should be observed in an attempt to sectionalize the fault to a particular unit.

(2) *Operational tests.* Operational tests often indicate the general location of trouble. In many cases, the tests help to determine the exact nature of the fault. The equipment operational checklist (TM 11–5825–231–10), is a good test as a start. Additional tests are given in paragraph 3–9.

c. Localization. The tests listed below will aid in isolating the trouble. First localize the trouble to a single stage or circuit, and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements. Use the following methods of trouble localization:

(1) *Signal tracing.* Signal tracing in an orderly fashion through the units will help in isolating a trouble to a specific circuit at fault.

(2) *Voltage and resistance measurements.* Certain units of the direction finder set are transistorized and only the specified voltages and resistance should be measured. Do not make any other measurements. (An accidental short or the application of a voltage from the ohmmeter battery is sufficient to burn out a transistor.) Use the voltage and resistance charts and compare them with the readings observed to locate the fault.

(3) *Troubleshooting chart.* The trouble symptoms and causes listed in the troubleshooting chart will aid in localizing trouble to a component part.

(4) *Stage gain chart.* Where applicable, certain units may be checked more readily by inserting a known voltage and observing the output voltage to determine individual stage gain. Comparison can be made with values listed in the chart.

(5) *Intermitten troubles.* Intermittent troubles, often difficult to trace, may be made to appear by methodically tapping with an insulated probe in the area of suspected trouble. Faulty

tubes, components, and connections are often discovered by this method.

(6) *Signal substitution.* By introducing a signal normally processed by a unit, the repairman may check a unit rapidly, localizing the trouble to a particular stage.

d. Troubleshooting Procedures. The troubleshooting procedures in this chapter follow the format and the general conditions presented below. Direct and general support personnel will perform these tests, unless final testing only is specified.

(1) *Checking B+ and filament circuits for shorts.*

(*a*) *Purpose.* These tests are resistance checks to determine whether a short circuit exists in the unit.

(*b*) *When to check.* When previous testing indicates a short circuit in the unit, or a unit is received with unknown symptoms, these test should be performed before applying power to the unit.

(*c*) *Conditions for tests.* Disconnect all external cables from the unit and remove it from the console. Set all controls and switches in their normal operating positions.

(*d*) *Test equipment required.* A multimeter is the only test equipment required to perform these tests.

(2) *Bench tests.*

(*a*) *Purpose.* These tests are used to isolate the trouble in a unit to a particular component. They are to be performed by direct support and general support personnel.

(*b*) *When to perform.* Bench tests are required when the operator or organizational tests indicate that a unit is malfunctioning. When no symptoms are known, perform short circuit tests on the bench before proceeding.

(*c*) *Conditions for tests.* Initial testing conditions for the bench tests are described in the bench test setup. Control settings for the unit under test and the test equipment are described in this section.

(*4*) *Test equipment required.* A list of the test equipment required is supplied with the description of the bench test setup.

(3) *Localizing trouble.* A series of test procedures are presented which isolate the malfunction to a single stage of the circuitry. When a test fails, refer to the accompanying troubleshooting chart for further testing.

(4) *Isolating trouble.* When the previous tests have failed to locate the defective component, the additional procedures presented under this heading are to be followed.

4-3. Test Equipment Required

The following charts (*a* through *c* below) list test equipment required for troubleshooting the direction finder set. The chart also includes specially fabricated test fixtures for simplifying testing procedures. For completing some of the test setups, operating units of the system used are listed in *b* below.

a. Test Equipment.

Federal stock No.	*Equipment*	*Common name*	*Reference*
6625-553-0142	Multimeter TS-352B/U	Multimeter	TM 11-6625-366-15
6625-911-6368	Counter, Electronic Digital Readout AN/URM-207	Counter	TM 11-6625-700-10
6625-228-2201	Oscilloscope AN/USM-281A	Oscilloscope	TM 11-6625-1703-15
6625-868-8353	Generator, Signal AN/GRM-50	Rf generator	TM 11-6625-573-15
6625-868-8352	Generator, Signal AN/URM-103	Fm signal generator	TM 11-6625-586-12
6625-783-5965	Generator, Signal AN/URM-127	Audio signal generator	TM 11-6625-683-15
5950-235-2086	Transformer, Power, Variable CN-16/U	Variac	
6625-643-1670	Voltmeter, Electronic ME-30B/U	Ac vtvm	TM 11-6625-320-12
6625-913-9781	Multimeter ME-26B/U	Dc vtvm	TM 11-6625-200-15
6625-376-4939	Test Set, Electron Tube TV-7B/U	Tube tester	TM 11-6625-274-12

b. Direction Finder System Units.

Equipment	*Common name*
Drive, Goniometer-Rotary Coupler TG-126(*)/TRD	Goniometer drive
Amplifier, Electronic Control AM-3545/TRD	Control amplifier
Power Supply PP-4482/TRD	Power supply
Receiver, Radio R-725/URR	Receiver

c. Test Fixtures. The following test fixtures are to be fabricated by the user facility.

Equipment	*Reference*
Test fixture, power supply	Figure 4–26
Test fixture, phase shift network	Figure 4–17

Section II. DS AND GS TROUBLESHOOTING PROCEDURES

WARNING

High voltages are present in the units of the direction finder set.

4–4. Scope of Troubleshooting Procedures

a. The troubleshooting procedures presented in this section cover all units in the direction finder set. They are designed to locate defective components within a unit. Interunit troubleshooting is accomplished using the procedures described in the operator's manual and chapter 3 of this manual.

b. When a defective component has been located, proceed to section III for instructions on repair or replacement.

4–5. Coupler, Antenna CU–1874/TRD–23A

a. Checking B+ Circuit for Shorts. See paragraph 4–2*d*(1) for a general description of these tests.

CAUTION

When measuring resistance in this transistorized circuitry, be certain that the (+) meter lead is attached to the B+ and the (−) meter lead to ground.

Chart 4–1. Short Circuit Tests—Antenna Coupler

Test points	*Isolating procedure*
E8 on power board A	*a.* High resistance indicates: (1) Open chock coil L1. (2) Broken lead. *b.* Low resistance indicates: (1) Short filter capacitor C1 or C2. (2) Shorted rectifiers CR1 through C4. (3) Shorted wiring.

b. Bench Test Setup.

(1) Bench testing the antenna coupler is required when interunit tests indicate that failure of system operation is caused by a malfunction within the unit.

(2) The following test equipment is required. Refer to paragraph 4–3 for a list of common names.

Federal stock No.	*Equipment*	*References*
6625–7836–5965	Generator, Signal AN/URM–127	TM 11–6625–683–15
5820–069–8915	Radio Receiver R–725/URR	TM 11–5825–231–25
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
6625–913–9781	Multimeter ME–26B/U	TM 11–6625–200–15
5950–235–2086	Transformer, Variable, Power CN16/U	

(3) Connect the test equipment as shown in figure 4–1.

(4) Set the controls on the equipment as follows:

Equipment	*Control*	*Setting*
Antenna coupler	TEST METER switch	OFF
	POWER	OFF
Rf generator	FREQUENCY	3 MHz
	ATTENUATOR	0.1 volt
	MODULATOR selector	Cw
Receiver	FREQUENCY	3 MHz
Ac vtvm	SENSITIVITY	0.1 volt

c. Localizing Troubles. Perform the following tests to localize the malfunction to a section or stage in the circuit. Refer to the trouble-shooting chart when a test fails. Refer to the pictorial view (fig. 4–2) to locate components.

(1) Turn on the antenna coupler and set the line voltage to 115 volts with the variac.

(2) Rotate the antenna coupler TEST METER switch through all positions and compare the readings with those given in paragraph 3–8*c*.

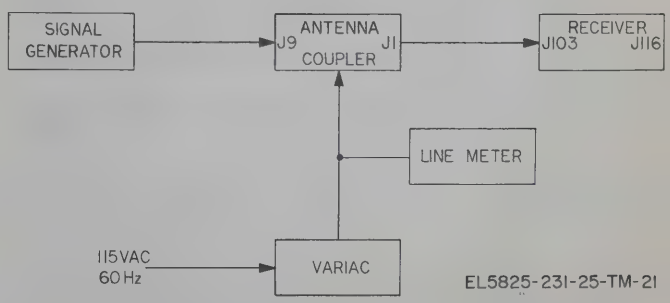


Figure 4–1. Test setup, antenna coupler.

Chart 4-2. Antenna Coupler Troubleshooting

Item	Trouble	Probable cause	Remedy
1	TEST METER switch readings: A1Q1 & A1Q2, or A2Q1 & A2Q2 high.	No voltage regulation or transistor shorted.	Check indicated transistor and Zener diode CR5.
2	TEST METER switch readings: A1Q1 & A1Q2, A2Q1 & A2Q2 low.	No voltage regulation or transistor open.	Check indicated transistor and Zener diode CR5.
3	TEST METER BIAS reading high.	No voltage regulation	Check Zener diode CR5.
4	TEST METER BIAS reading low.	No B+	Check B+ circuits.
5	TEST METER B+ reading high.	Transistor open	Check transistors.
6	B+ meter reading low	*a.* Rectifier open *b.* Filter leaking *c.* Transistor shorted	*a.* Check CR1 through CR4. *b.* Check filter capacitors C1 and C2. *c.* Check transistors.
7	No signal output	Open connection	Check connector cables between subassemblies.
8	Signal loss at high frequencies	*a.* Defective coupling capacitor *b.* Line input filter defective	*a.* Check capacitors A1C2 and A1C3. *b.* Check filter FL2.
9	Signal loss at low frequencies	*a.* Open choke coil *b.* Line input filter defective	*a.* Check coil A1L3. *b.* Check filter FL2.
10	No power input	*a.* Blown fuse *b.* Defective switch *c.* Defective powerline filter *d.* Defective power transformer	*a.* Check fuses F1 and F2. *b.* Check POWER switch S1. *c.* Check filter FL1. *d.* Check transformer T1.

(3) For gain test, turn on the rf generator and compare the rf input at J9 with the rf output at J1 using the ac vtvm. The output should be as large as the input.

(4) Bandpass test is as follows:

(*a*) Connect the ac vtvm to J116 on the receiver, and adjust the receiver tuning for maximum output on the ac vtvm.

(*b*) Vary the rf generator output between 2 and 20 MHz, maintaining constant voltage, and adjust the receiver tuning for peak output on the ac vtvm at each frequency.

(*c*) The peak readings on the ac vtvm should not vary appreciably over the band.

d. Isolating Troubles. When trouble has been localized to a stage, use the following techniques to isolate the defective component.

CAUTION

When making resistance measurements in this unit be certain that the (−) meter lead is connected to ground.

(1) Test the suspected transistor or substitute a similar type.

(2) Perform voltage measurements using the chart below. All voltages are given relative to chassis, and should be measured with an ac vtvm. Refer to figure FO-21 for the location of the test points.

Chart 4-3. Voltage chart—antenna coupler

Test point	Typical voltage (dc)
A1E1	+30 ±0.9
A1E2	+10 ±0.1
A1E3	+0.8 to +1.1
A1E4	+0.8 to +1.1
A2E1	+30 ±0.9
A2E2	+10 ±0.1
A2E3	+0.9 to +1.25
A2E4	+0.9 to +1.25
FL1 (across terminals 1 and 2)	115 volts ac ±3.5

4-6. Drive, Goniometer-Rotary Coupler TG-126(*)/TRD

a. Bench Test Setup (fig. 4-3).

(1) Bench testing the goniometer drive is required when the interunit tests or checks indicate that failure of the system is caused by a malfunction within the unit.

(2) The following test equipment is required. Refer to paragraph 4-3 for common names.

Federal stock No.	Equipment	References
5820-069-8915	Radio Receiver R-725/URR	TM 11-5825-231-35
5825-918-6991	Amplifier, Electronic Control AM-3545/TRD	TM 11-5825-231-35
6625-053-3112	Oscilloscope AN/USM-281A	TM 11-6625-1703-15
5950-235-2086	Transformer, Variable, Power CN-16/U	
6625-868-8353	Generator, Signal AN/GRM-50	TM 11-6625-573-15

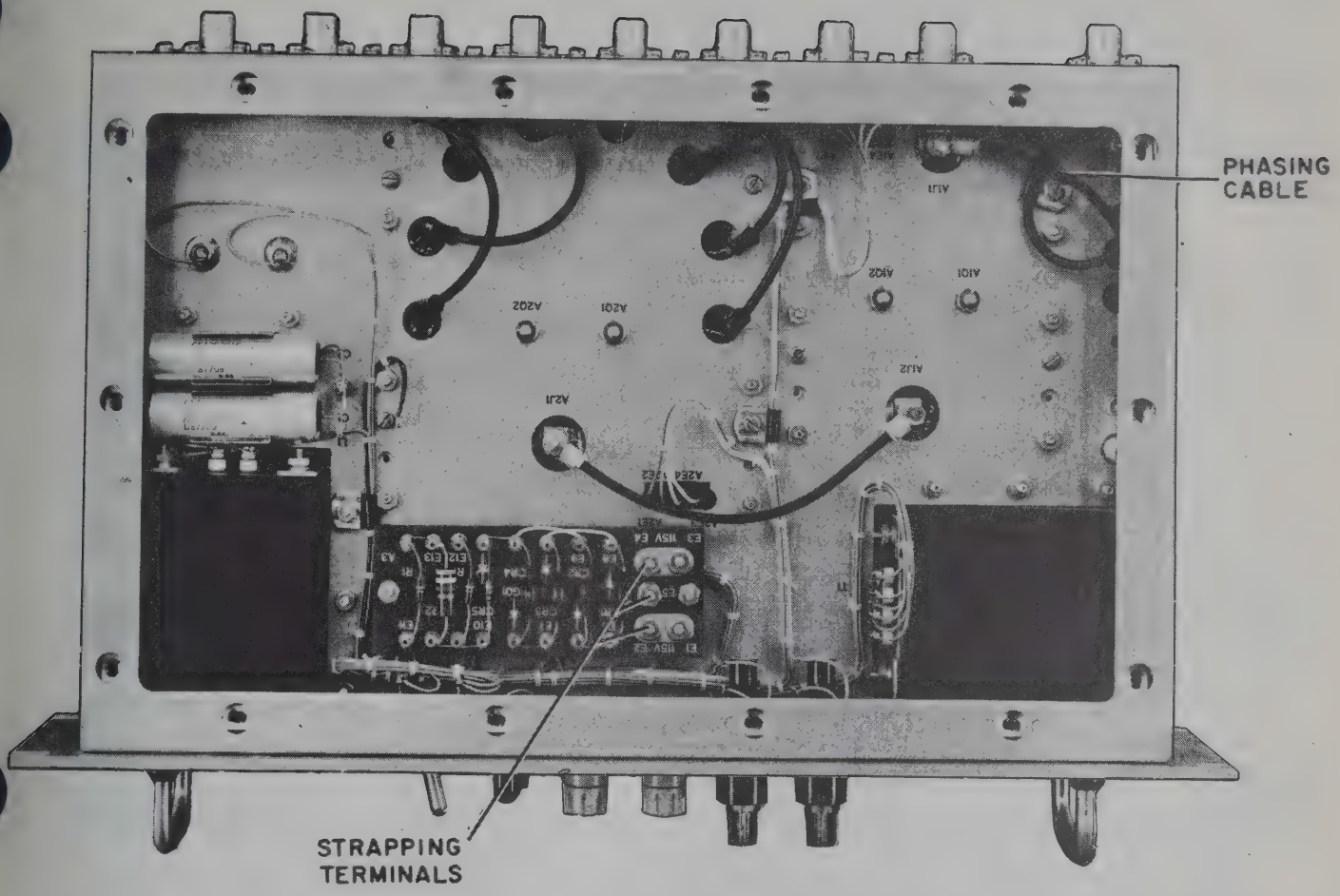


Figure 4–2. Antenna coupler, bottom view.

(3) Connect the equipment as shown in figure 4–3.

(4) Set the equipment controls as follows.

Equipment	*Control*	*Setting*
Receiver	FREQUENCY	10 MHz
Rf generator	FREQUENCY	10 MHz
	OUTPUT	100-volts
	MODULATION	Cw
Oscilloscope	INPUT (chan 1)	1 volt/cm
	INPUT (chan 2)	10 volts/cm
	SWEEP	10 msec/cm

b. Localizing Troubles. Perform the following tests to localize the malfunction to a section or a stage in the circuit. Refer to the troubleshooting chart when a test fails. The pictorial views (fig. 4–5 through 4–8) show component locations.

(1) *Preliminary.* Turn on control amplifier, and adjust line voltage to 115 volts with the variac.

(2) *Sync pulse.* Adjust the oscilloscope SWEEP control to display two sync pulses. The pulses should be at least 1 volt peak-to-peak and less than 2 milliseconds wide.

(3) *Drive motor speed.* With the scope probe, measure the 180-Hz motor drive at C3 in the goniometer drive unit. If the motor is up to speed, one sync pulse appears for every two cycles of the 180-Hz motor drive voltage.

(4) *Rotary coupler rf coupling.*

(*a*) Turn on the rf generator and tune the receiver for maximum signal on the CARRIER LEVEL meter. Connect the scope probe to the if. output at J116 on the receiver.

(*b*) Adjust the oscilloscope sweep and the sensitivity to produce the bell-shaped curve shown at A, figure 4–4.

(5) *Rotary coupler bandpass.*

(*a*) Readjust the oscilloscope controls to produce the waveform shown at B, figure 4–4.

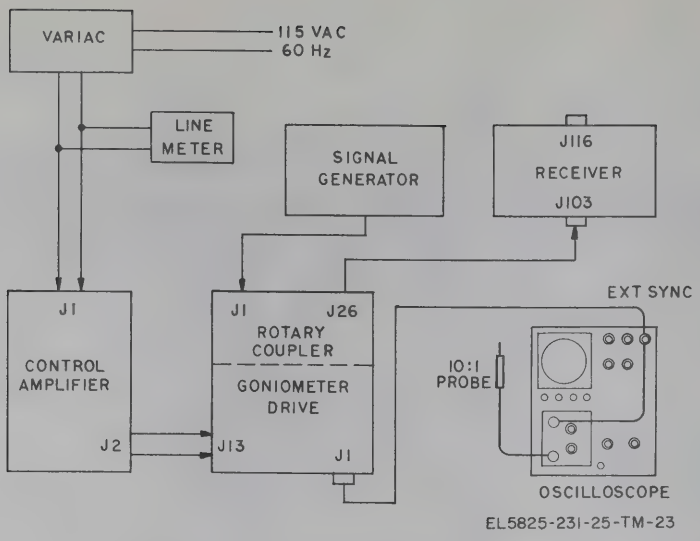


Figure 4–3. Test setup, goniometer drive.

(*b*) Vary the rf generator frequency from 1.5 MHz to 20 MHz, peaking the receiver tuning throughout. The if. output should be essentially the same magnitude through the entire band. Reset the rf generator to 10 MHz.

(6) *MONITOR-D.F. relays rf check.*

(*a*) Disconnect the receiver from J26 on the rotary coupler and reconnect the original cable to J26.

(*b*) Connect the receiver to J4 on the goniometer drive chassis. Observe the same signal as in (5) (*a*) above.

(*c*) Move the receiver connection to J9 on the goniometer drive chassis. Observe the same signal as in (5) (*a*) above.

(*d*) Disconnect the receiver, oscilloscope, and rf generator.

(7) *Goniometer check.*

(*a*) Connect the rf generator to J1 on the goniometer to be tested. Adjust the controls for a 1-volt, 72-kHz signal output.

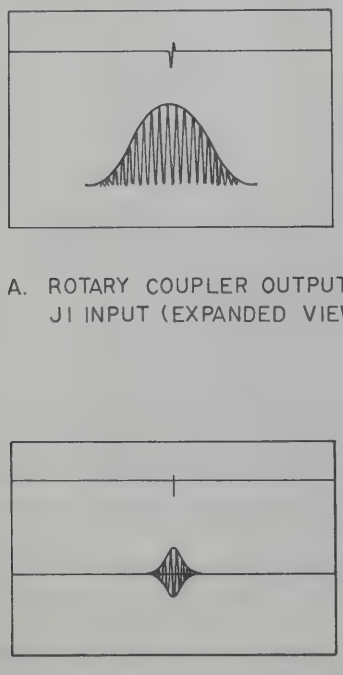
(*b*) Insert the scope probe into J2 and its ground lead into J3 on the goniometer. Adjust the oscilloscope controls to display the 72-kHz, 1-volt signal output of the goniometer.

(*c*) Repeat (*b*) above using J4 and J5 for the oscilloscope connections.

c. Isolating Troubles.

(1) When trouble has been localized to the MONITOR-D.F. relays, use the following resistance/continuity chart and a multimeter to check the circuits.

(2) For signal tracing, refer to the schematic diagram (fig. FO–9) and unit functioning (para 2–6*c*).



A. ROTARY COUPLER OUTPUT
J1 INPUT (EXPANDED VIEW)

B. ROTARY COUPLER OUTPUT
J1 INPUT
EL5825-231-25-TM-24

Figure 4–4. Rotary coupler, output waveforms.

4–7. Amplifier, Electronic Control AM–3345/TRD

(fig. FO–1)

a. Checking B+ Circuits for Shorts. Refer to paragraph 4–2*d*(1) for a general description of the tests.

CAUTION

When measuring resistance in this transistorized circuitry, be certain that the

Chart 4–4. Troubleshooting—Goniometer Drive

Item	Trouble	Probable cause	Remedy
1	Drive motor will not run	*a.* Defective capacitor	*a.* Check C2, C3, and C6.
		b. Motor winding open	*b.* Check motor windings for continuity at P1.
		c. Defective connector	*c.* Check J13 for corrosion, loose wires, etc.
2	No sync pulse output	*a.* Broken drive belt	*a.* Check drive belt.
		b. Defective clipper	*b.* Check CR1 and CR2.
		c. Open capacitor	*c.* Check C1.
		d. Defective pickup coil	*d.* Check L1.
3	No goniometer output	Defective windings	Check goniometer windings for opens or shorts.
4	No rotary coupler	Defective coils	Check coil resistance (less than 1 ohm).
5	Primary MONITOR-D.F. relays inoperative.	*a.* Relay failure	*a.* Check coils of K1 and K2.
		b. Rectifier failure	*b.* Check CR3 and C4.
		c. Defective connector	*c.* Check J5 for corrosion, loose wires, etc.
6	Secondary MONITOR-D.F. relays inoperative.	*a.* Relay failure	*a.* Check coils of K3 and K4.
		b. Rectifier failure	*b.* Check CR4 and C5.
		c. Defective connector	*c.* Check J10 for corrosion, loose wires, etc.
7	Drive motor not running at proper speed.	*a.* Control amplifier	*a.* Check control amplifier.
		b. Defective drive motor	*b.* Check drive motor windings for continuity at P1.
8	Df indication off course	Goniometer flexible coupling	Adjust flexible coupling (para 4–24).

Chart 4–5. MONITOR-D.F. Relay Resistance/Continuity

Mode	Relays	From	To	Normal Indication
D.F. (deenergized)	K1 and K2	J3–1	J4–1	Short
		J3–2	J4–2	Short
		J6 center cond.	J14 center cond.	Short
	K3 and K4	J8–1	J9–1	Short
		J8–2	J9–2	Short
		J12 center	J15 center	Short
MONITOR (energized)	K1 and K2	J3–1 and 2	J4–1 and 2	Open
		J4–1 and 2	Ground	51 ohms
		J6 center	J14 center	Open
	K3 and K4	J8–1 and 2	J9–1 and 2	Open
		J12	J15	Open
		J9–1 and 2	Ground	51 ohms

(+) meter lead is attached to the B+ and the (−) meter lead to ground.

Chart 4–6. Short Circuit Tests—Control Amplifier

Test points	Resistance (ohms)	Isolating procedure
C11 (+) to ground	10	High resistance resistor R27 open. Low resistance indicates: (1) Resistor R27 shorted. (2) Diode CR8 or CR9 shorted. (3) Filter capacitor C10 or C11 shorted. (4) Transistor Q4 or Q5 shorted.
XMP 7 to ground (MP7 removed)	640	High resistance indicates: (1) Resistor R16 open. (2) Transistors Q4 and Q5 open. Low resistance indicates: (1) Transistor Q1, Q2, or Q3 shorted. (2) Shorted wiring.

b. Bench Test Setup.

(1) Bench testing of control amplifier is required when inter-unit tests indicate that failure of system operation is caused by a malfunction within the unit.

(2) The following test equipment is required:

Federal stock No.	*Equipment*	*References*
6625–913–9781	Multimeter ME–26B/U	TM 11–6625–200–15
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
5950–914–6807	Drive, Goniometer, Rotary Coupler TG–126(*)/U	TM 11–5825–231–25
5825–918–6991	Amplifier, Electronic Control AM–3345/TRD	TM 11–5825–231–25
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
5950–235–2086	Transformer, Variable, Power CN–16/U	

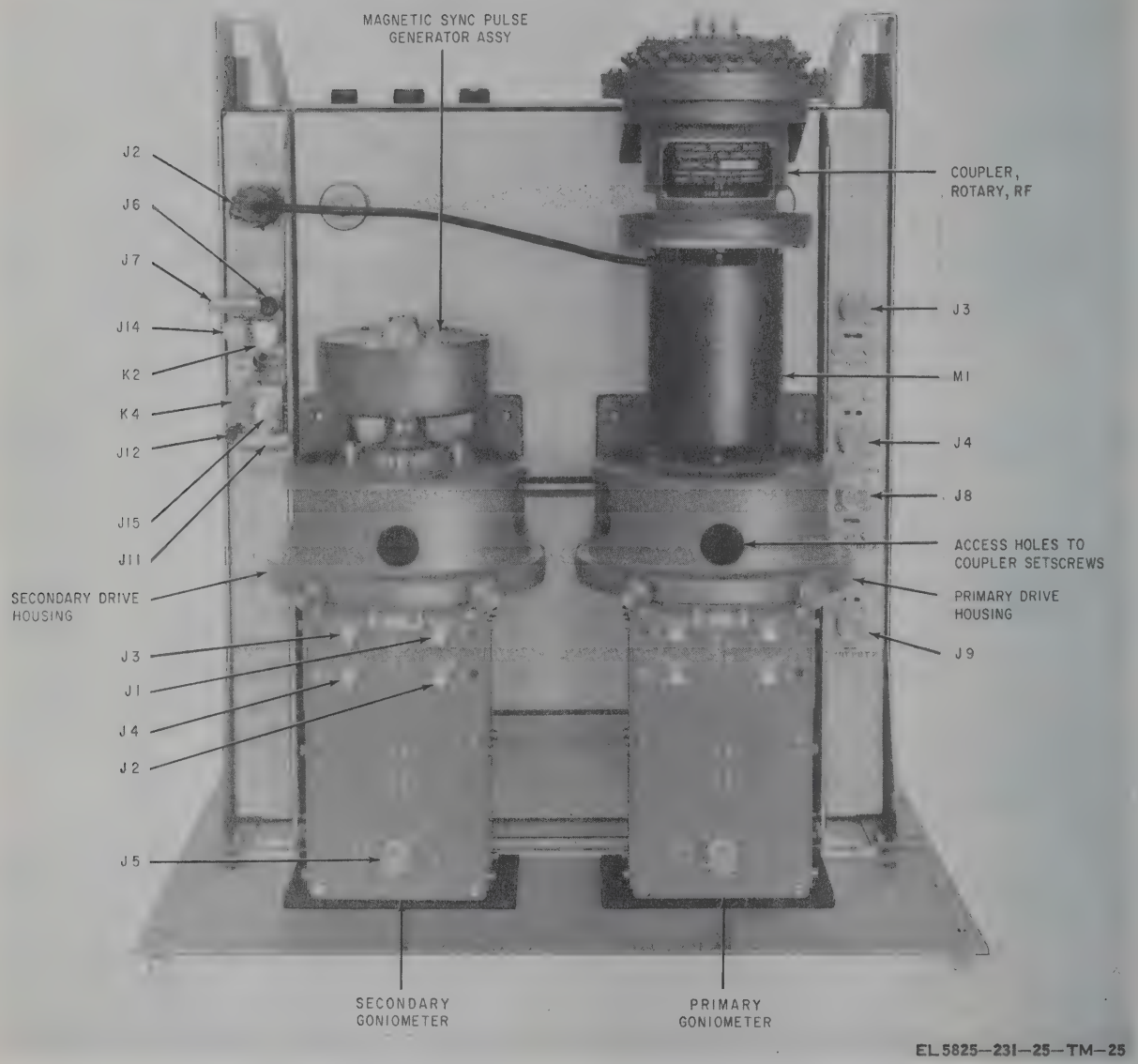


Figure 4–5. Goniometer drive, top view.

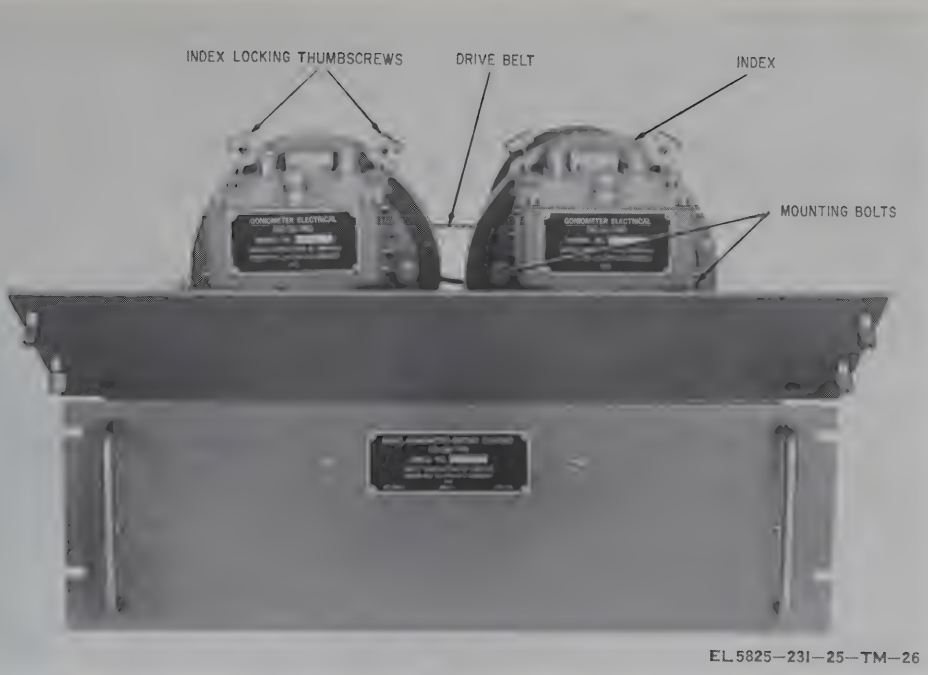


Figure 4-6. Goniometer drive, front view.

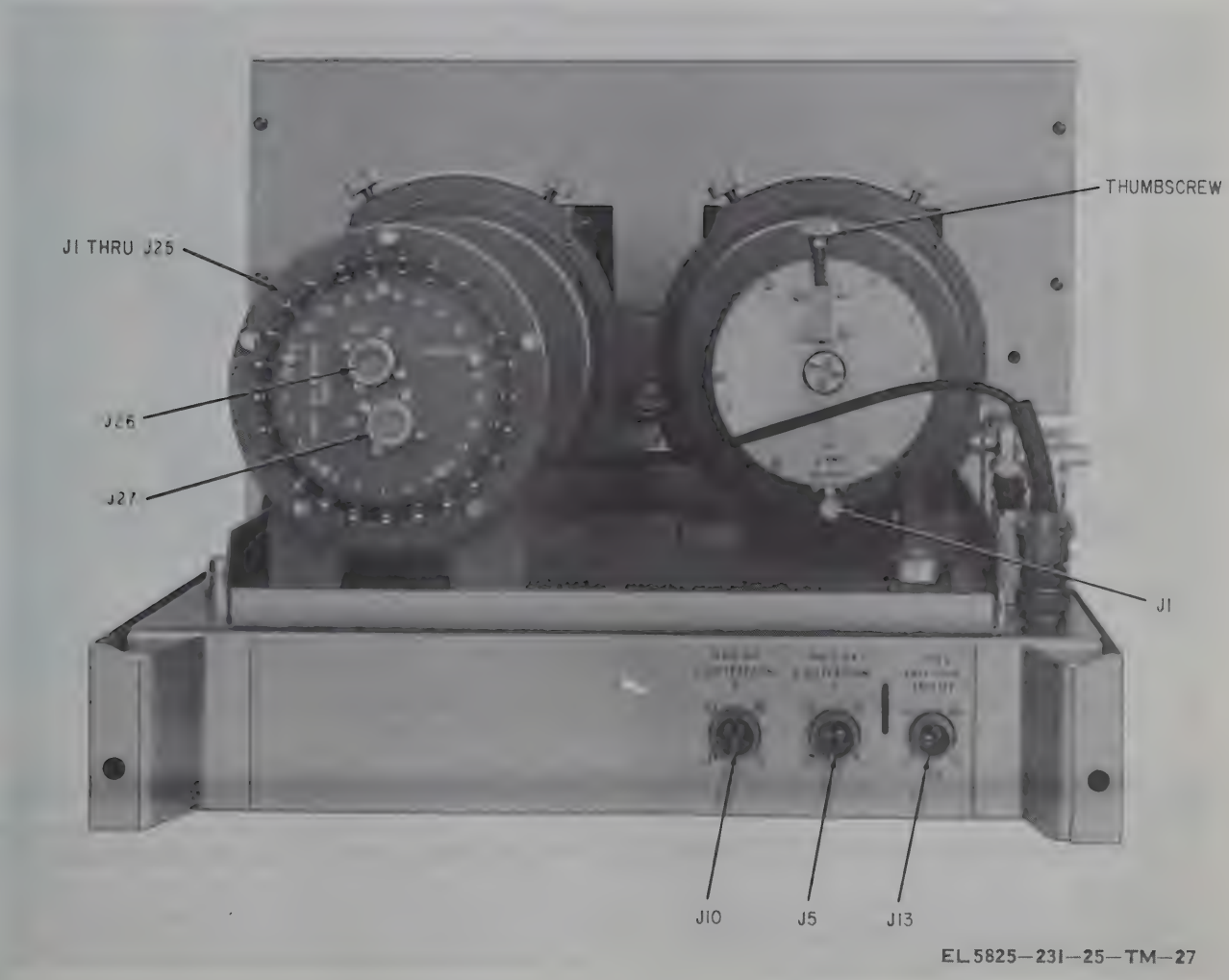


Figure 4-7. Goniometer drive, rear view.

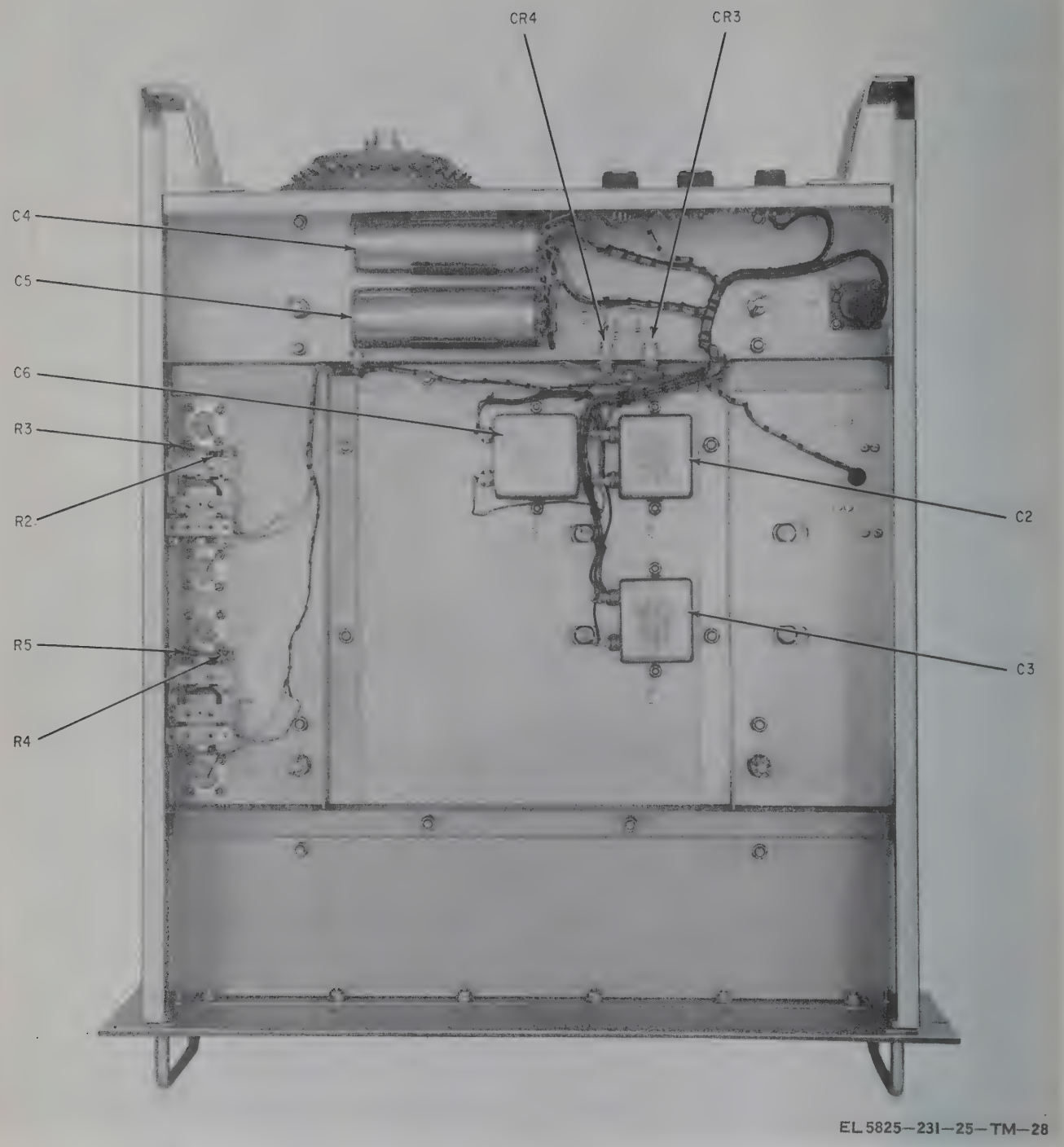


Figure 4–8. Goniometer drive, bottom view.

(3) Connect the test equipment shown in figure 4–9.

(4) Set the oscilloscope controls as follows:

Control	*Setting*
INPUT	0.2 volts/cm
SWEEP	1.0 msec/cm
SYNC INPUT	EXT

c. Localizing Troubles. Perform the following tests to localize the malfunction to a circuit section or stage. Refer to the troubleshooting chart when a test fails. The component locations are shown in figures 4–10 and 4–11 and 4–12.

(1) *Preliminary.* Turn on the control ampli-

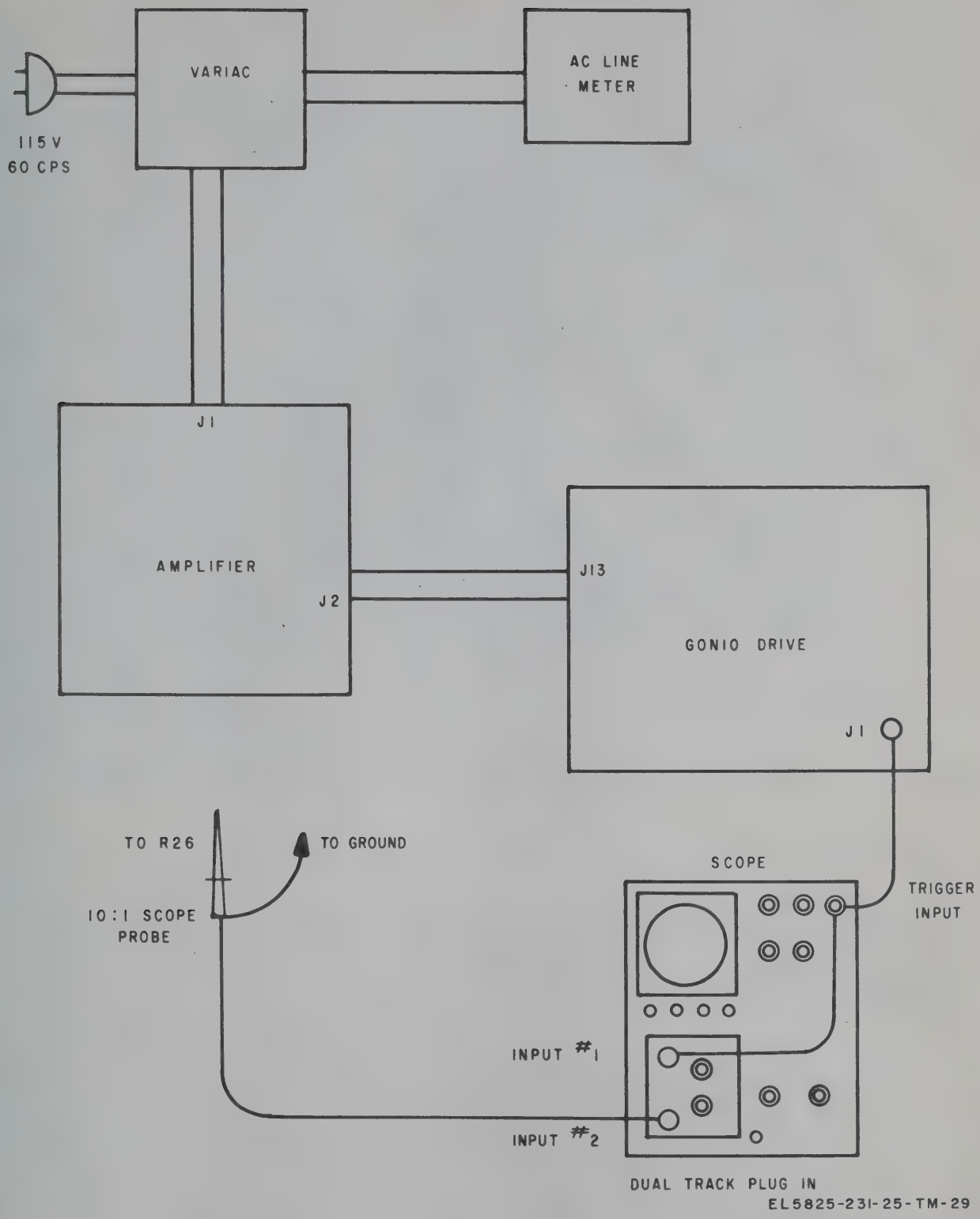


Figure 4-9. Test setup, control amplifier.

fier and adjust the line voltage to 115 volts with the variac.

(2) *Tuning fork frequency.* With the scope probe, measure the tuning fork output frequency at TP10 in the control amplifier. One cycle should be 5.5 cm (5.5 millisecond) long.

(3) *Output power.* Adjust the oscilloscope sweep to display two sync pulses. With the scope

probe on TP10, observe exactly two cycles of the tuning fork output for every sync pulse. This test indicates that the control amplifier has enough power output to run the goniometer drive motor at the proper speed.

(4) *No load test.* Turn off the control amplifier and remove fuse F2. Turn on the control amplifier and with the scope probe, check for 180-Hz signal at TP4. None should be present.

d. Isolating Troubles. If the previous tests have not uncovered the defective components, continue troubleshooting with the following procedures:

(1) *Voltage measurements.* Voltage measurements for two control amplifier load conditions are given in the following chart. Ac voltages are peak to peak. Measurements are taken with ME-26B/U.

(2) *Signal tracing.* Refer to the schematic diagram (fig. 6-13) and the unit function given in paragraph 2-7.

4-8. Receiver, Radio R-725/URR

a. Modification Data. The R-725/URR is a modified R-390A/URR receiver. The following modifications have been accomplished:

(1) Replaced if. subchassis to improve performance when receiver is used in conjunction with direction finding equipment (fig. FO-4).

(2) The following wiring modifications have been made to reduce hum (fig. 6-5):

(*a*) Open small enclosure at end of vfo unit and lift pin 3 of V701 from ground.

(*b*) Connect a 0.01-uf capacitor between V701-3 and ground.

(*c*) Connect V701-3 to J709-C. Solder connections and close up vfo.

(*d*) Connect P109-C to P121-E (filament return).

(*e*) Disconnect and dead-end wire (with tape) from P112-8.

Chart 4-7. Troubleshooting—Control Amplifier

Item	Trouble	Probable cause	Remedy
1	No output voltage	*a.* Defective tuning fork	*a.* Replace.
		b. No B+	*b.* See item 3.
		c. Shorted transistor	*c.* Check Q2.
		d. Defective amplifier	*d.* Check driver and final amplifier stages.
2	Low power output	*a.* Gain set too low	*a.* Check setting of R4.
		b. Defective power supply	*b.* See items 3 and 4.
		c. Defective transistor	*c.* Check transistors.
3	No B+	*a.* Defective rectifier	*a.* Check CR8 and CR9.
		b. Defective filter	*b.* Check C11 and R27.
		c. Defective transformer	*c.* Check T4.
4	No regulated B+	*a.* Open transistor	*a.* Check Q10.
		b. No regulator bias	*b.* Check Zener diode CR5 and bias resistor R18.
		c. Shorted component	*c.* Check for shorts.
5	No-load circuit	*a.* Shorted transistor	*a.* Check Q2.
		b. Defective sensing circuit	*b.* Check R25.
		c. Defective component	*c.* Check components.
6	Incorrect tuning fork frequency	Defective tuning fork	Replace.

Chart 4-8. Voltage Measurements—Control Amplifier

Load	100 watts across J2						No load across J2					
Stage	Base		Emitter		Collector		Base		Emitter		Collector	
	VDC	VAC	VDC	VAC	VDC	VAC	VDC	VAC	VDC	VAC	VDC	VAC
Q1	5.8	2.5	5.4	2.4	10.5	0	6.0	2.6	5.4	2.6	10.7	0
Q2	0	0.3	0	0	5.8	1.9	0.6	0	0	0	0.1	0
Q3	5.8	1.3	4.2	1.0	10.5	0	4.8	0	4.2	0	10.7	0
Q4	0.5	0.7	0	0	12.0	25.0	0.5	0	0	0	15.0	0
Q5	0.5	0.9	0	0	11.7	25.0	0.5	0	0	0	15.0	0.2
Q6	3.0	14.0	0	0	12.1	2.0	0	0	0	0	15.0	0.2
Q7	4.1	13.0	0	0	12.1	1.8	0	0	0	0	15.0	0.2
Q8	12.1	2.0	12.3	1.4	2.3	24.0	15.0	0.2	15.0	0.2	0	0
Q9	12.1	1.8	12.3	1.4	2.2	22.0	15.0	0.2	15.0	0.2	0	0
Q10	11.2	0	10.5	0	12.9	0.5	11.4	0	10.7	0	15.4	0.3

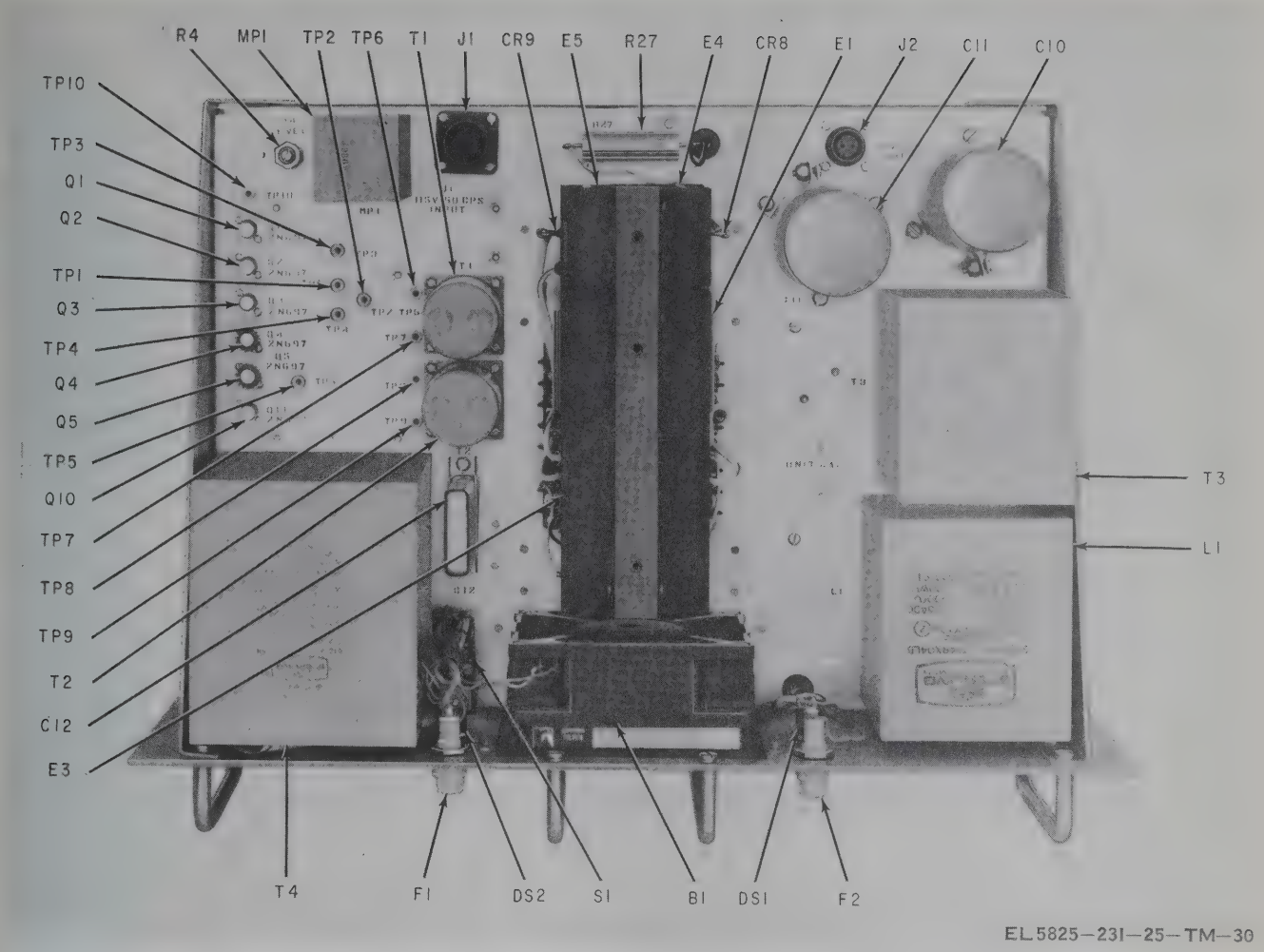


Figure 4–10. Control amplifier, top view.

(*f*) Connect P112–8 to P121–F (filament supply).

(*g*) Parallel-connect a wire from P111–7 to P121–A (primary supply).

(*h*) Parallel-connect a wire from P111–6 to P121–B (primary supply).

(*i*) Parallel-connect a wire from P11902 to P121–C (B+ supply).

(*j*) Connect a wire from P121–D to chassis ground.

(3) See figure 61 in TM 11–5820–358–35 for results of wiring modification. Filament voltage of the vfo from V701–3 to ground now measures 25 volts dc. Resistance from V701–3 to ground now measures 33 K. These are the only voltage/resistance changes caused by the wiring modification described in (2) above.

b. Checking B+ and Filament Circuits for Shorts. Refer to paragraph 4–*d*(1) for a general description of these tests. The information supplied in TM 11–5820–358–35 covers these tests, except that the resistance at test point J512–2 should be 35K.

c. Bench Test Procedures. Procedures for the receiver are described in TM 11–5820–358–35. Follow normal procedures for testing the receiver as outlined in this section, except for the following:

(1) If. troubleshooting chart below is substituted for troubleshooting chart in TM 11–5820–358–35.

(2) If. subchassis components are identified in figures 4–13, 4–14, and 4–15.

(3) Tube voltage and resistance diagram, if subchassis, in TM 11–5820–358–35 is replaced by the diagram in figure 6–10.

(4) Substitute if. stage gain test (*f* below) for if. test TM 11–5820–358–35.

d. If. Subchassis. The troubleshooting chart below outlines procedures for localizing troubles to a stage in the if. subchassis, and indicates probable cause and recommended solutions. If recom-

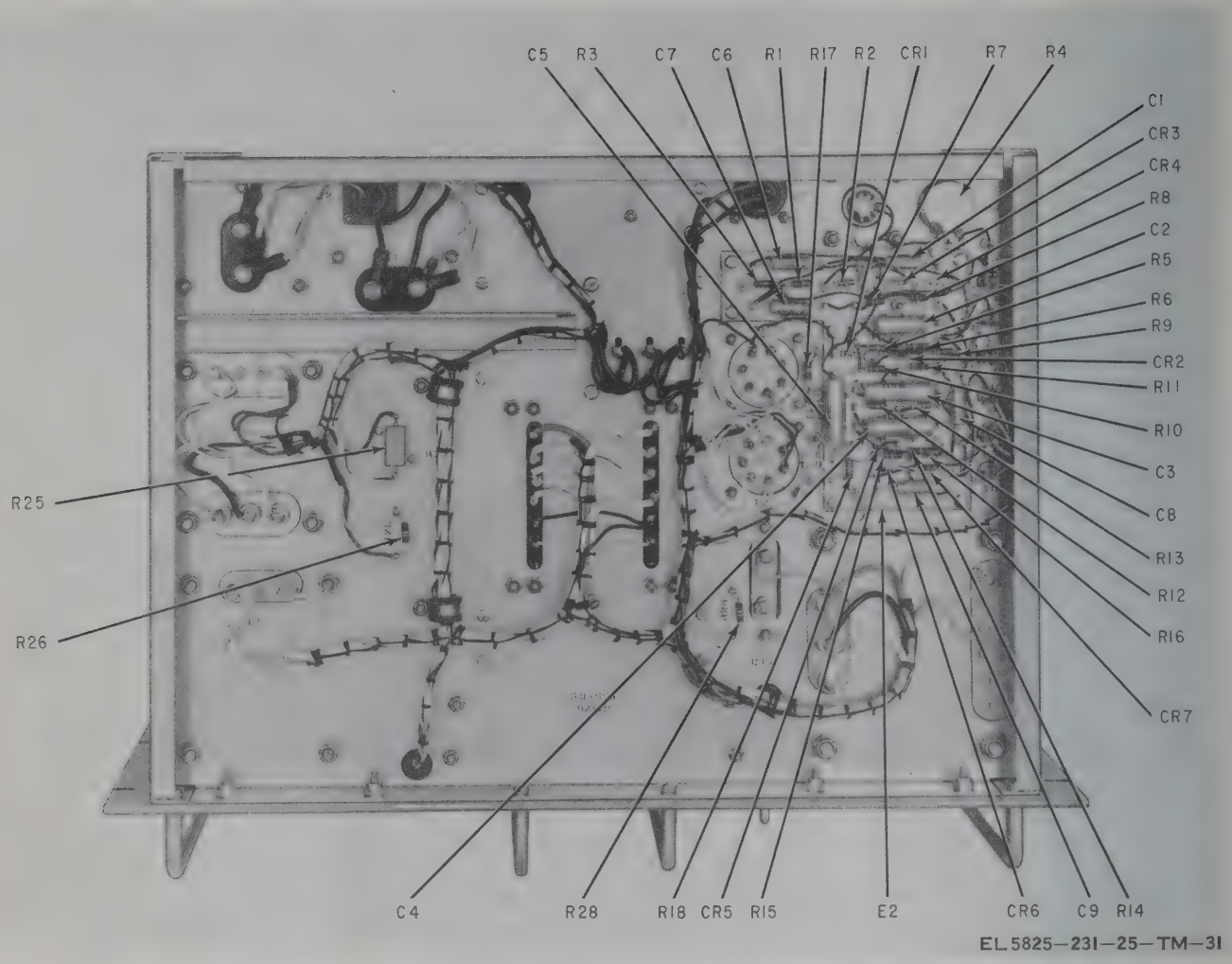


Figure 4–11. Control amplifier, bottom view.

mended solution does not solve problem, make voltage and resistance checks in accordance with figure 6–10 and correct deficiency. Figures 4–13, 4–14, and 4–15 show the location of components.

e. If. Stage Gain Test. This test supplements tests in TM 11–5820–358–35, and will indicate trouble in the first six stages of the if. subchassis. If a stage reads outside charted values, replace faulty component before proceeding to the next stage.

(1) The stage gain chart below lists the minimum and maximum voltages required at each of the if. stages of the receiver to produce a voltage of −7 volts dc across the diode load. Use this chart as a standard when troubleshooting to check the gain of each if. stage or group of stages. When the receiver output is low and the tubes are operating satisfactorily (as indicated by a tube tester), localize the defective stage by checking the signal voltage level of each state against the chart while using the signal substitution method of troubleshooting, or by measuring the individual stage gain.

(2) To obtain the stage gain readings, connect a multimeter between terminals 14 (DIODE LEVEL) and 16 (GND) of the terminal strip on the back of the receiver. Terminal 14 must be jumpered to terminal 15. Connect the ground lead of the rf generator to the receiver ground, and connect the generator output lead through a 0.1 μf capacitor to the receiver points indicated in the chart. When checking the 455-kHz if. stages, the injection points can be reached by operating the subchassis outside the receiver, using the extension cables, or by inserting a short length of wire into the tube socket terminal. Check the output from the rf generator required to obtain the diode load reference voltage of −7 volts dc against the figures given in the charts.

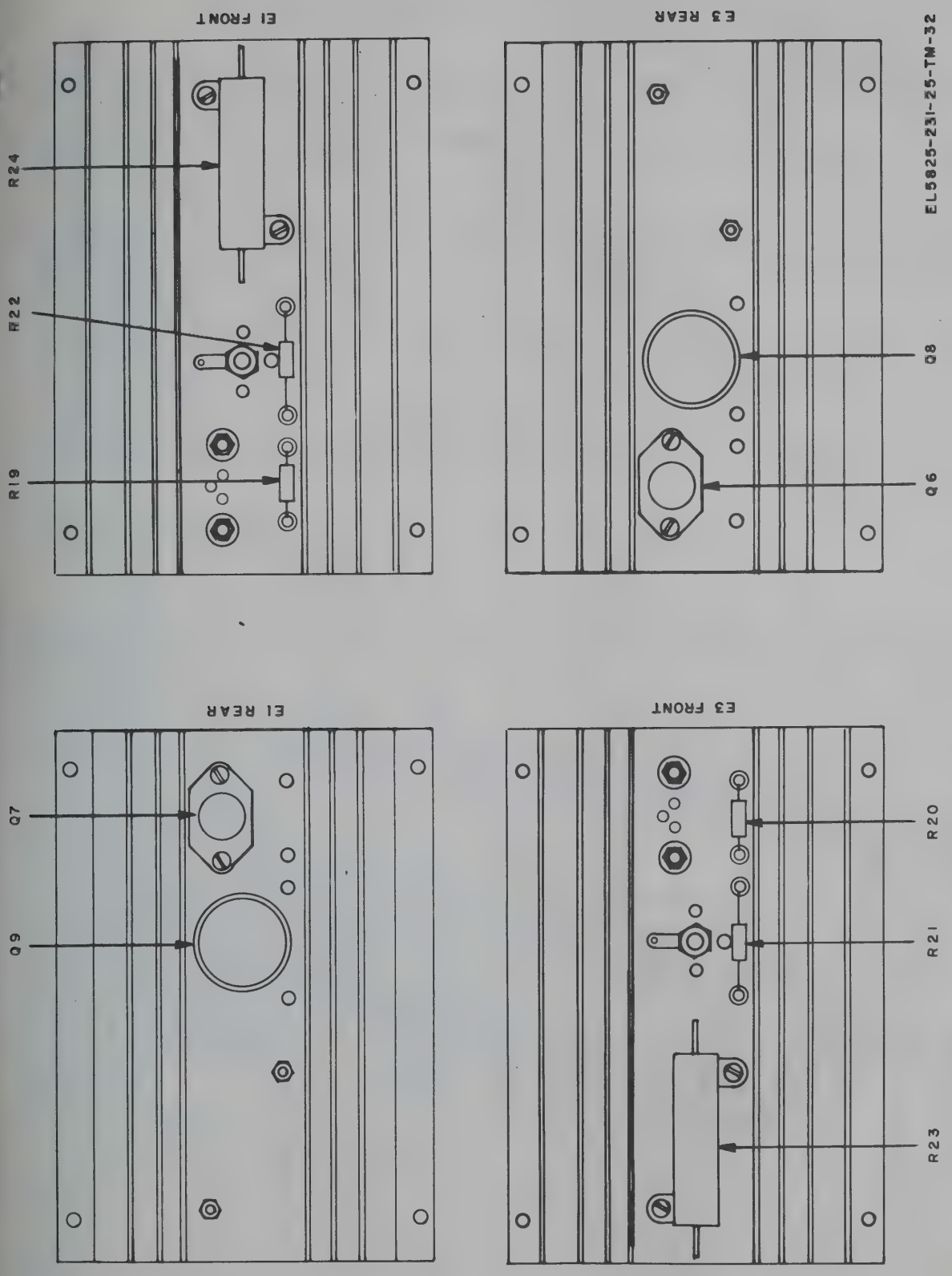


Figure 4-12. Control amplifier, component assemblies, E1 and E3.

Chart 4-9. Troubleshooting—Receiver If. Strip

Item	Trouble	Probable cause	Remedy
1	No signal or weak signal when af signal is applied to pins 1 and 2 of tube socket XV510, anode of positive peak limiter.	Capacitor C259, V510	Check components and replace defective part.
2	Weak signal output when af signal is applied to pin 3 of tube socket.	V510 defective, or R542, R544 open	Check and replace component if defective.
3	Weak signal output when af signal is applied to pin 3 of tube socket XV507, cathode of positive peak limiter.	V510 defective or R542, R544 open	Check and replace component if defective.
4	Weak or no output signal when 455-kc modulated signal is applied at pins 1 and 2 of tube socket XV507.	Defective tube or loose jumper between terminals 14 and 15 or rear terminal strip.	Tighten terminals 14 and 15 jumper connections and replace V507 if defective. If trouble persists, check voltage and resistance of circuit components.
5	Weak output when 455-kHz modulated signal is applied to pin 5 of tube socket XV506, plate of sixth if. amplifier.	T506 open or shorted or not properly aligned.	Check and replace T506 if open or shorted. For alignment, refer to chapter 4.
6	Apply 455-kHz modulated signal to pin 1 of V506, grid of sixth if. amplifier. Output should be louder than in step 5.	Open C523 or C524, or defective tube.	Shunt capacitors with ones of like value and replace if defective. Check V506.
7	If. subchassis still defective	Defective if. stage	Refer to paragraph 3-9*e* for if. stage gain test and replace defective component.

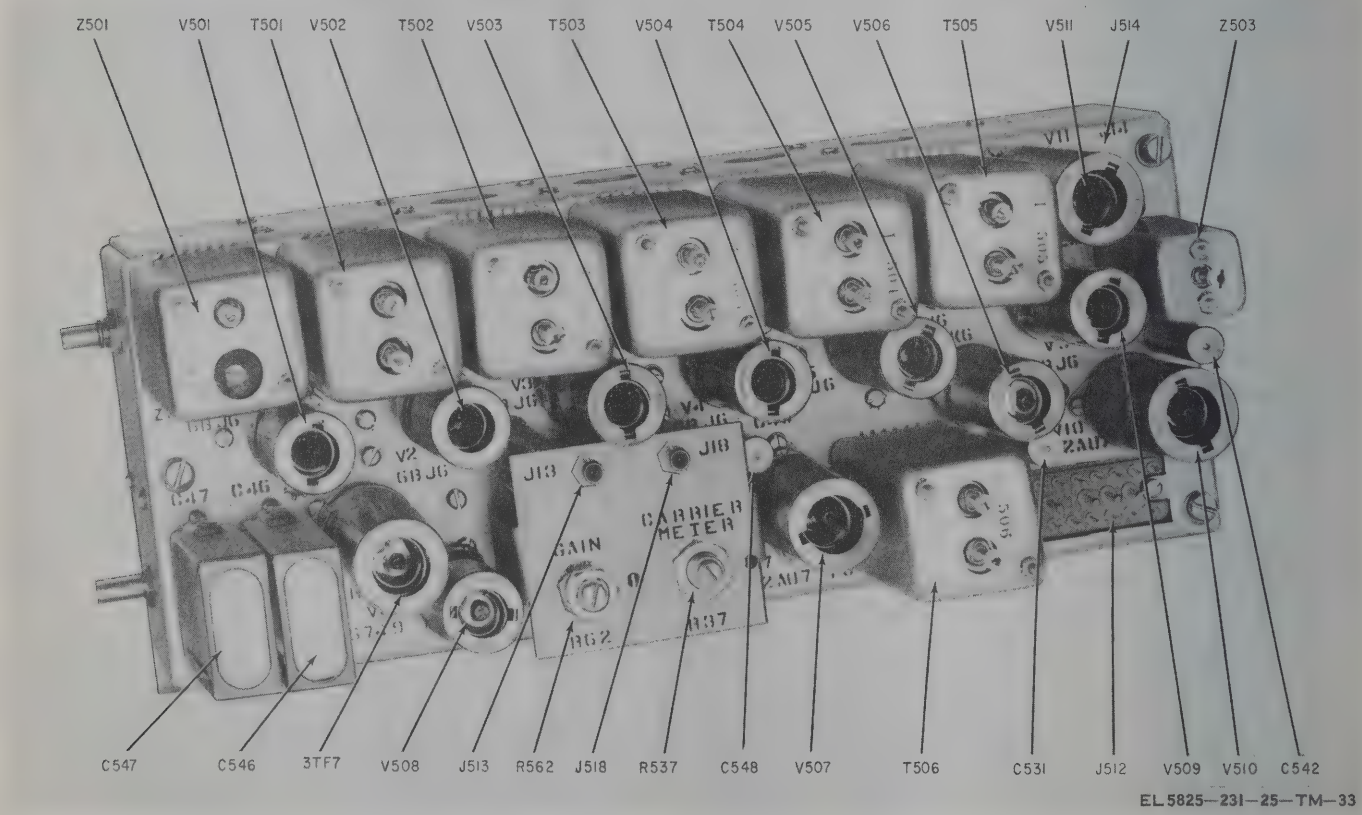


Figure 4-13. If. subchassis, top view, location of components, tubes, transformers & controls.

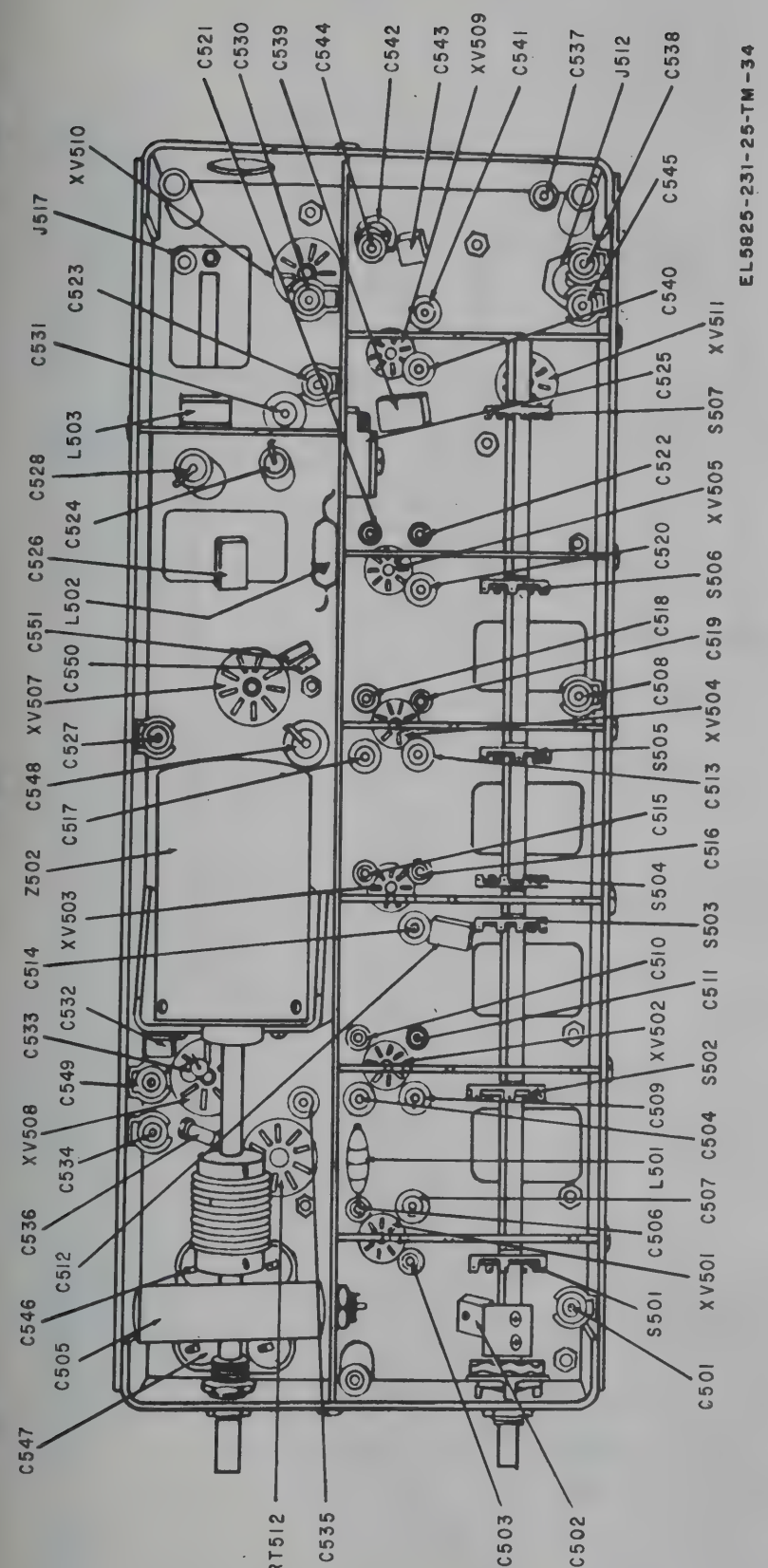


Figure 4-14. If. subchassis, location of components, capacitors.

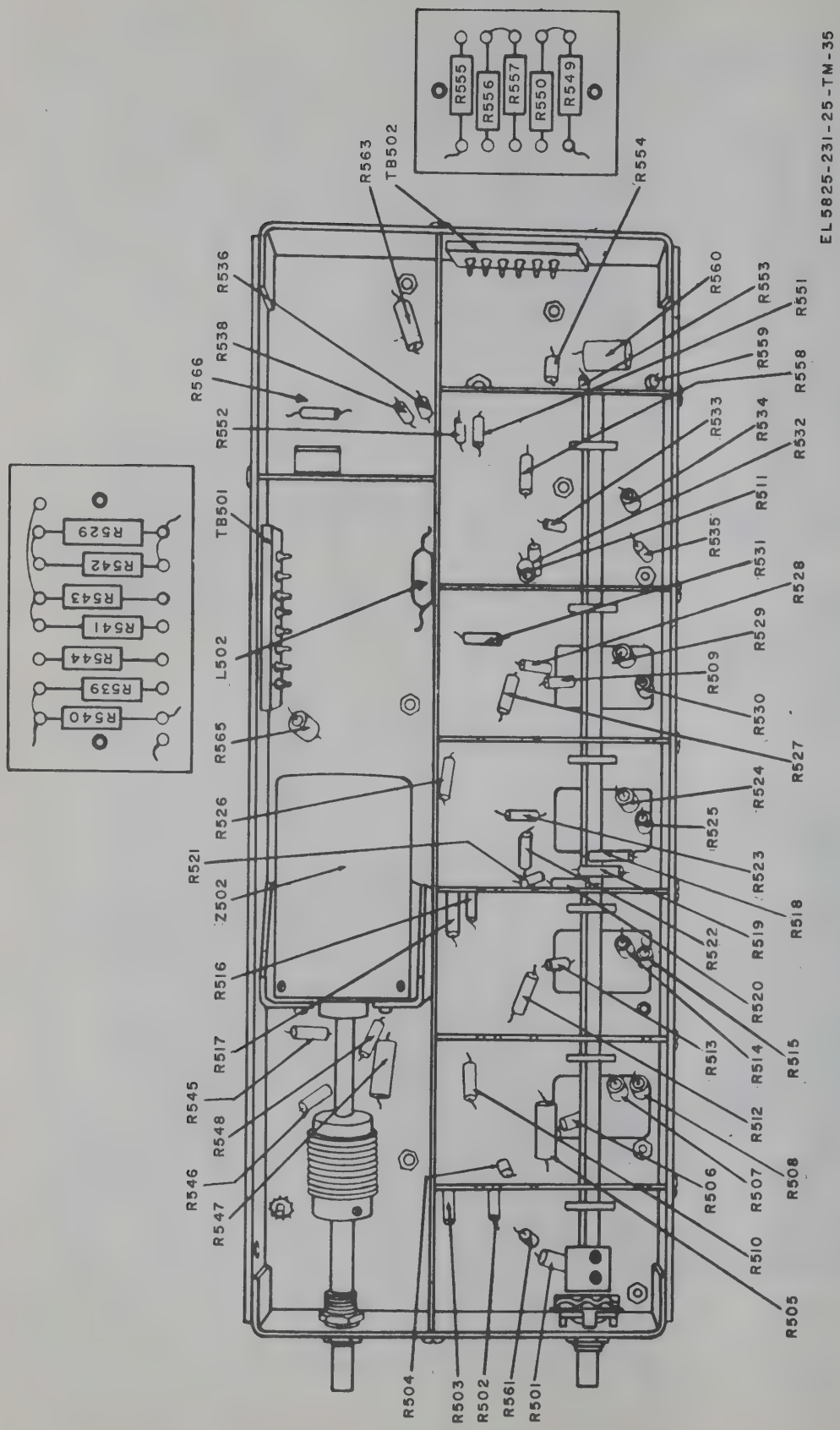


Figure 4-15. If. subchassis, location of components, resistors.

The lowest figure is the minimum and the highest is the maximum that should be required over the specified frequency range for normal operation. However, a reading that is slightly outside this range does not necessarily indicate improper functioning.

Chart 4–10. If. Stage Gain

Signal injection point	Rf generator output (millivolts) bandwidth			
	2 kHz	4 kHz	8 kHz	16 kHz
V501 grid	0.13–0.18	—	—	—
V502 grid	1.5–1.9	1.4–2.0	0.88–1.4	0.86–1.7
V503 grid	2.3–5.0	3.0–5.0	1.1–2.0	0.77–1.3
V504 grid	7.0–12.0	7.0–11.5	6.0–8.7	5.2–7.6
V505 grid	16.0–20.0	16.0–18.0	23.0–28.0	32.0–38.0
V506 grid	420–500	420–500	420–500	420–500

4–9. Detector, Radiofrequency RD–159(*)/TRD

a. Checking B+ and Filament Circuits for Shorts. Refer to paragraph 4–2*d*(1) for a general description of these tests.

Chart 4–11. Short Circuit Tests—Rf Detector

Test points	*Resistance*	*Isolating procedure*
TP 13 to ground	240 K	A low resistance indicates: (1) Breakdown of wiring insulation. Check all B+ wiring and lead dress of components for possible short or arc-over chassis. (2) Component failure. Remove all tubes one at a time observing any significant change in B+ resistance to ground. Return tubes to appropriate socket immediately after it has been determined that the tube is not defective. Check capacitors for leakage, especially C4, C11, C16, C22, C26, C31, C36, C41, C47, C51, C55, C61, C63, C65, C71, C76, C78, C80, C81, and C90.
J8–A to ground	Infinite	Remove all tubes identifying each with the location from which they were taken. Measure infinite resistance across the test points as a check against filament wiring shorts.
J8–B to ground	Infinite	Same as above.
J8–A to J8–B	Infinite	Same as above. Replace tubes in sockets from which they were removed.

b. Bench Test Setup.

(1) Bench testing of rf detector is required when interunit tests indicate that failure of system operations is caused by a malfunction within the unit.

(2) The following test equipment is required:

Federal stock No.	*Equipment*	*References*
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–6625–320–12
6625–783–5965	Generator, Signal AN/URM–127	TM 11–6625–683–15
6625–911–6368	Counter, Electronic Digital Readout AN/URM–207	TM 11–6625–700–10
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
NSN	Phase shift network (locally fabricated)	Fabricate as directed in figure 4–17, TM 11–5825–231–25
5825–914–8831	Power Supply PP–4482/TRD	TM 11–5825–231–25
6625–868–8353	Generator, Signal AN/GRM–50	TM 11–6625–573–15
5950–235–2086	Transformer, Power, Variable CN–16/U	
6625–868–8352	Generator, Signal AN/URM–103	TM 11–6625–586–12
5820–069–8915	Receiver, Radio R–725/URR	TM 11–5825–231–25

(3) Connect the test equipment as shown in figure 4–16.

(4) Fabricate a phase-shift network test fixture as shown in figure 4–17. This fixture provides the 90° phase shift required for a straight line oscilloscope presentation.

(5) Set equipment controls as follows:

Equipment	*Control*	*Setting*
Audio Oscillator AN/URM–127	FREQUENCY	90 Hz
	OUTPUT control	Set for indication of 1.0 on panel meter.
	FREQ RANGE MULTIPLIER	X1
	ATTENUATOR	X100
Oscilloscope AN/USM–281	Horizontal DISPLAY switch	EXT SENS
	Horizontal amplifier external input coupling switch (AC DC)	AC
	Channel A input coupling switch (AC GND DC)	AC
	Channel A VOLTS/DIV control	Adjust for correct pattern
	Channel A VOLTS/DIV switch	50 mv/DIV
	Vertical DISPLAY switch	A
	Channel A POLARITY switch	+ UP
Signal Generator AN/URM–103	BAND SWITCH	Band A 18 28 MEGAHERTZ
	LO-HI RF SET TO LINE control	Adjust to set meter to line.
	FUNCTION switch	EXT MOD
	DEVIATION RANGE KHZ control	10
	LO RF uV control	100 uv
	RF OUTPUT switch	LO 0 10 uV
	DEVIATION control	Set to get stable pattern.

Note: For counter control settings, see TM 11–6625–700–10.

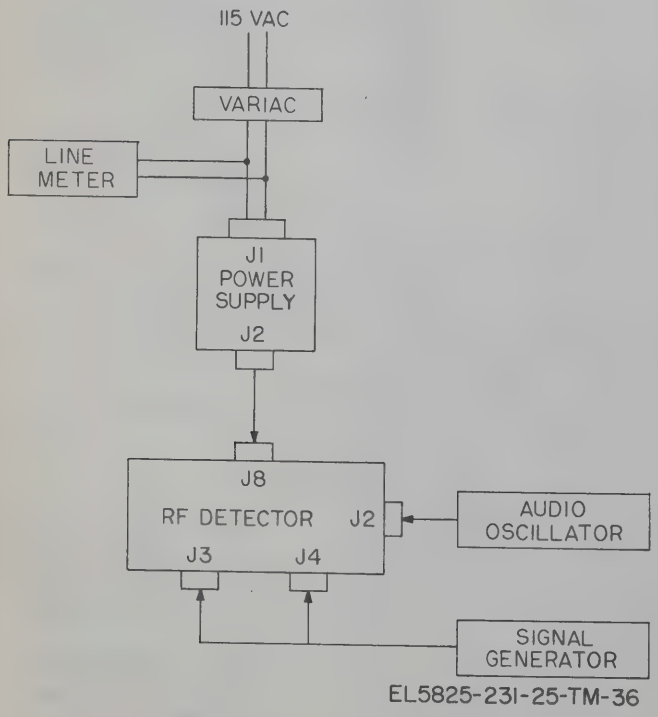


Figure 4–16. Bench test setup, rf detector.

c. Localizing Troubles. Perform the following tests to localize the malfunction to a section or stage in the circuit. Refer to the troubleshooting chart when a test fails. Refer to figures 4–20 through 4–24 to locate components.

(1) *Preliminary.* Turn on the power supply and adjust the line voltage to 115 volts with the variac.

(2) *Loudspeaker.* Turn on the audio signal generator, and note a 1,000 Hz tone from the loudspeaker. Disconnect the audio oscillator.

(3) *455-kHz oscillator.* With the scope probe, observe a 455-kHz signal, between 1.0 and 8.0 volts peak-to-peak, at TP1.

(4) *1 RCVR–2 RCVR relay.* With a jumper lead, short out the two contacts of J1, noting that the 455-kHz signal observed in (3) above disappears. Leave the jumper connected.

(5) *5-kHz signal output.* Turn on Signal Generator AN/GRM–50. With the scope probe, observe a 5-kHz signal, 0.2 to 2.0 volts peak-to-peak, at TP9. No amplitude modulation should appear on this waveform. Vary the input from the signal generator between 2 millivolts and 500 millivolts. The amplitude of the 5-kHz signal should remain essentially constant.

(6) *Limiter check.*

(*a*) Remove crystals Y2 and Y3 from their sockets.

(*b*) With the scope probe, observe a 15- to 20-volt peak-to-peak, 455-kHz signal at TP3 and TP7.

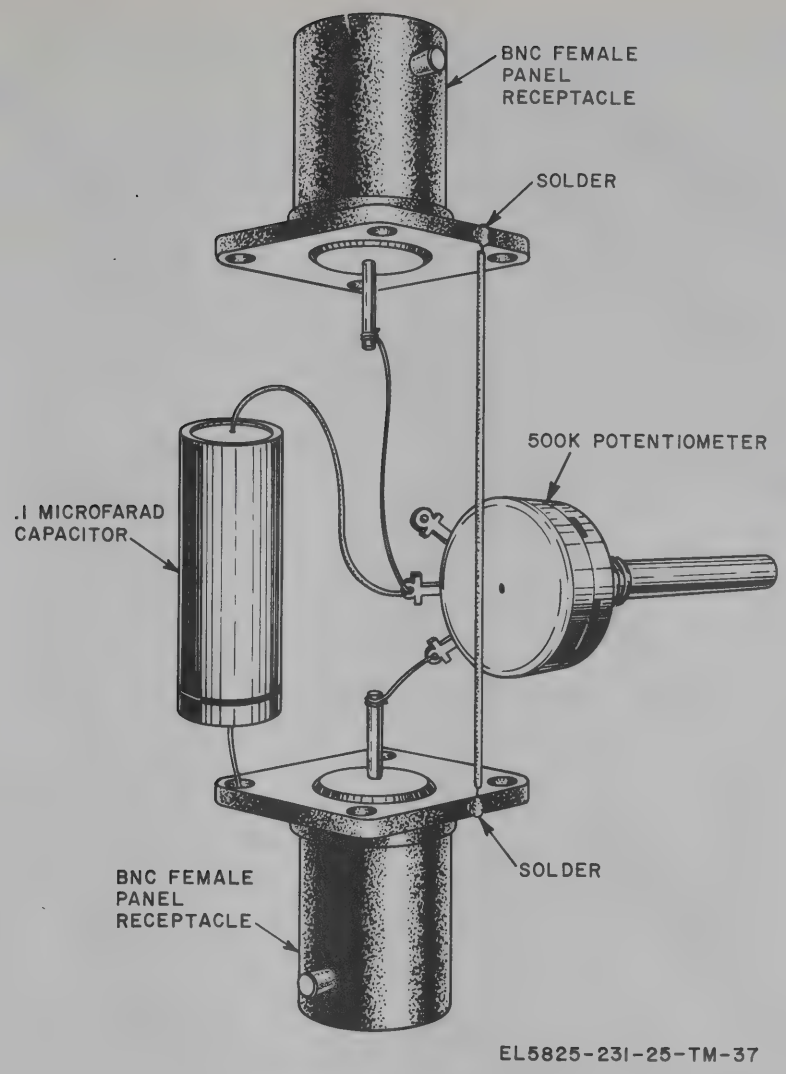


Figure 4–17. Test fixture, phase-shift network.

(*c*) Examine the signal for amplitude or frequency modulation. The maximum acceptable modulation is 2 percent am. and 5 percent fm.

(*d*) Frequency modulation appearing on this signal is an indication of nonsymmetrical limiting.

(*e*) Replace the crystals in their sockets.

(7) *Filter output.* With the scope probe, observe that no signal output is at output terminal of FL2.

(8) *Df signal output.*

(*a*) Disconnect Signal Generator AN/GRM–50 from J3 and J4, and remove the jumper from J1.

(*b*) Connect the 455-kc output of Receiver Radio R–725/URR to J4 as shown in figure 7–14.

(*c*) Check the 455-kHz if. output with the frequency counter.

(*d*) Set the oscilloscope sweep to 10 msec/cm and INT sync.

(*e*) With the scope probe connected to TP11, observe a 100 Hz sine wave. Adjust DF LEVEL control R89 for an amplitude of 5.0 volts peak-to-peak.

(9) *Harmonic distortion check.* Set the oscilloscope HORIZ INPUT to EXT x 1 and with the scope probe, observe the signal at TP11. Adjust the phase-shift network (fig. 7–14) and the oscilloscope controls to produce the pattern shown at A, figure 4–18.

(10) *Auxiliary output.*

(*a*) Set the oscilloscope HORIZ INPUT switch to INT. With the scope probe, observe a 3.5- to 12-volt peak-to-peak, 100-Hz signal at TP12.

(*b*) Reduce the deviation on Signal Generator AN/URM–103. The amplitude of the 100-Hz signal should be reduced.

(*c*) Disconnect the test setup shown in figure 7–14.

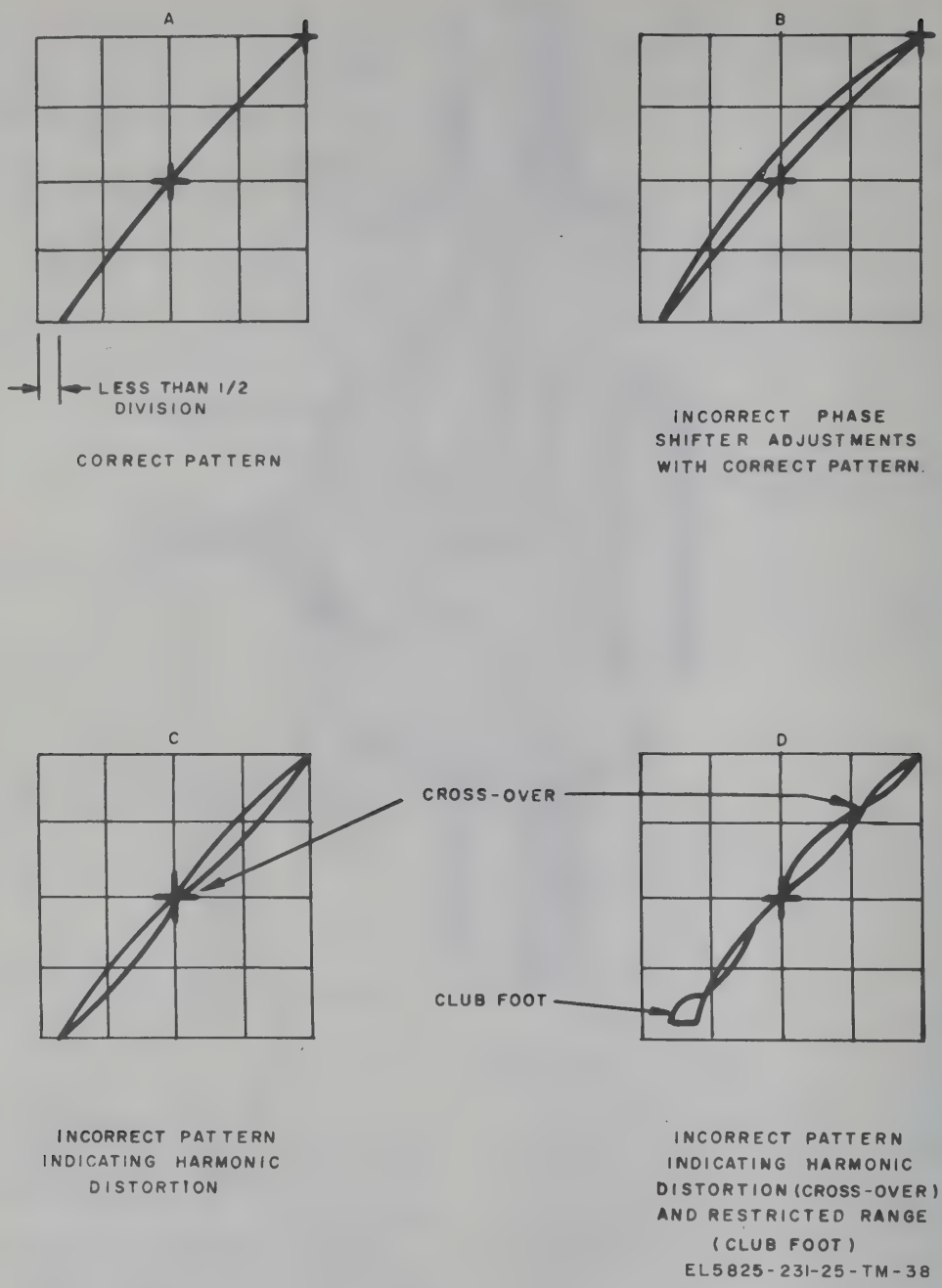


Figure 4–18. Test patterns, rf detector.

(11) *Harmonic filter rejection.*

(*a*) Connect the equipment as shown in figure 4–19.

(*b*) Set the AN/URM–127 to 90 Hz as measured on the AN/URM–207, and set the oscillator output level to give an indication of +10 dbm on the ME–30/U.

(*c*) Tune the oscillator to 180 Hz, 270 Hz, and 360 Hz, consecutively, using the AN/URM–207 to check the frequencies. The output from the harmonic filters should be −20 dbm or less for each frequency.

d. Isolating Troubles. When trouble has been localized to a stage through the preceding checks, use the following techniques to isolate the defective component:

(1) Test the tube involved, or substitute a similar type (fig. 4–20, 21, and 23).

(2) Perform voltage/resistance measurements (fig. FO–1).

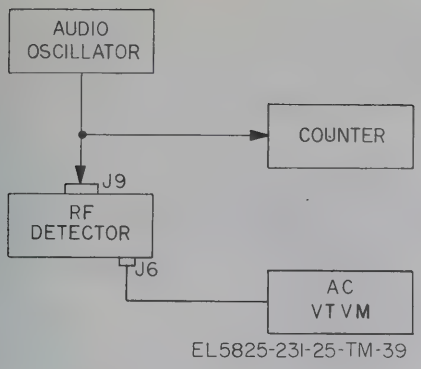


Figure 4–19. Test setup, harmonic filters.

(3) Perform signal tracing (fig. FO–6) and refer to the unit function given in paragraph 2–9.

4–10. Power Supply PP–4482/TRD

a. Checking B+ and Filament Circuits for Shorts. See paragraph 4–2*d*(1) for a general description of these tests.

b. Bench Test Setup.

(1) Bench testing the power supply is required when interunit tests indicate that failure of system operation is caused by a malfunction within the unit.

(2) The following test equipment is required. Refer to paragraph 4–3 for common names.

Federal stock No.	*Equipment*	*References*
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–6625–320–12
5950–235–2086	Transformer, Variable, Power CN–16/U	
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
NSN	Test fixture (fabricate)	Figure 4–26

Chart 4–12. Troubleshooting—Rf Detector

Item	*Trouble*	*Probable cause*	*Remedy*
1	No audio output	*a.* Defective transformer	*a.* Check T1.
		b. Open speaker voice coil	*b.* Check LS1.
		c. Defective receptacle	*c.* Check J2.
		d. Defective component	*d.* Check C9, C10, L3, L4.
2	No 455-kHz oscillator output	*a.* Defective relay	*a.* Check L1.
		b. Defective oscillator	*b.* Follow isolating procedures to locate defective component.
3	No. 2 df receiver input absent	Defective relay	Check K1.
4	No 5-kHz signal at TP9	*a.* Defective limiter	*a.* Check receiver 1 and receiver 2 limiter chains. See Item *5*.
		b. Defective mixer/oscillator	*b.* Check outputs of mixer/oscillators at TP4 and TP8.
		c. Defective mixer/amplifier	*c.* Check V12 circuit using isolating procedures.
		d. Defective filter	*d.* Check FL1.
5	No limiting at TP7 or TP3	Defective stage	Trace signal backward through circuit until defective stage is located. Then follow isolation procedures.
6	Low limiter output	*a.* Limiter misaligned	*a.* See adjustments (para 4–22).
		b. Defective stage	*b.* See item 5.
7	Fm	Unbalanced limiter stage	Trace signal forward through circuit until unbalanced stage is located. Then follow isolation procedures.
8	5-kHz signal at FL2	Defective filter	Check FL2.
9	No df output	*a.* Defective detector	*a.* Check detector components using isolation procedures.
		b. Defective amplifier	*b.* Check V16, V17, V18 amplifier stage.
		c. Defective filter	*c.* Check FL1, and harmonic filters.
		d. Defective control	*d.* Check R89.
10	Harmonic distortion	*a.* Misadjusted filter	a. See filter adjustments (para 4–22).
		b. Defective filter	*b.* Check components using isolation procedures.
11	No auxiliary output	*a.* Defective transformer	Check T2.
		b. Defective component	Check components using isolation procedures.

Chart 4–13. Short Circuit Tests—Power Supply

Test points	*Resistances*	*Isolating procedure*
TP1 to ground	108K	Lower than normal resistance indicates: *a.* Breakdown of wiring insulation: Check all B+ wiring and lead dress of components for possible short or arc-over to ground (chassis). *b.* Component failure: Remove control tube V2, amplifier tube V3, and reference tube V4, observing any significant change in B+ resistance to ground. Replace tube if a change is noted. Check capacitor C3 for leakage resistance and divider resistors for correct resistance value. Return tubes to sockets.
C1 (+) to ground		Lower than normal resistance indicates: *a.* Breakdown of wiring insulation. Check all wiring in the rectifier, control, amplifier, and reference circuitry for possible shorts in arc-over to ground. *b.* Component failure: Remove rectifier tube V1, observing any significant change in resistance. Check capacitors C1 and C2 for leakage resistance. Check 5V filament winding for leakage to ground. Return tube to socket.
J2–A to ground	31K	Lower than normal resistance indicates: *a.* Breakdown of wiring insulation: Visually inspect filament (6.3V) wiring. *b.* Component failure: Remove tubes V2 and V3, noting any significant change in resistance. Check transformer T1 for possible filament (6.3V) winding leakage or short to the frame. Return tubes to sockets.

(3) Connect the test equipment as shown in figure 4–25.

(4) Construct a test fixture as shown in figure 4–26. This fixture provides test points and dummy leads for the power supply. The loading may be varied by suitable switching.

(5) Set the controls on the equipment as follows:

Equipment	*Control*	*Setting*
Power supply	POWER (S1)	OFF
Multimeter TS–352B/U	SELECTOR	400 VDC
Test fixture	FILAMENT LOAD	OFF
	B+ LOAD	LIGHT
Oscilloscope	INPUT COUPLING	AC
	SENSITIVITY	10 mv/cm
	SWEEP	10 msec/cm

c. Localizing Troubles. Perform the following tests to localize the malfunction to a section or stage in the circuit. Refer to the troubleshooting chart when a test fails. Refer to figures 4–27 and 4–28 for component locations.

(1) *Preliminary.* Connect the TS–352B/U to the B+ test points (C and D) on the test fixture. Pin C is ground.

(2) *Apply power.* Turn the power supply POWER switch to ON. Adjust the line voltage to 115 volts with the variac.

(3) *B+ voltage.* The B+ voltage measured on the TS–352B/U should be 250 volts dc ±2. Adjust the OUTPUT VOLTAGE control, if necessary.

(4) *Voltage regulation.*

(*a*) Move the test fixture B+ LOAD switch to HEAVY. The B+ voltage on the TS–352B/U should remain the same.

(*b*) With the variac, change the line voltage between 105 and 125 volts; the B+ voltage should remain within tolerance (±2 volts). Return the line voltage setting to 115 volts.

(5) *Filament voltage.* Connect the TS–352B/U to the FILAMENT test points (A and B), with the selector switch set for the 10-volt ac range. Measure 6.3 volts ac ±0.3 on the meter. Move the FILAMENT LOAD switch to ON. The TS–352B/U indication should drop no more than 0.2 volt. Remove the TS–352B/U.

(6) *Hum and noise.* With the ME–30B/U, measure hum and noise present on the B+ at TP1 in the power supply. Adjust HUM BALANCE control R2, if necessary, to obtain less than 0.25 volt peak-to-peak hum.

d. Isolating Troubles. If the previous tests have not uncovered the defective components, continue troubleshooting as follows:

(1) *Voltage/resistance measurements.* Refer to the voltage/resistance chart (fig. 6–9).

(2) *Signal tracing.* Refer to the schematic diagram (fig. FO–3) and the unit functioning given in paragraph 2–10.

4–11. Indicator, Azimuth IP–669/TRD

a. Checking B+ and Filament Circuits for Shorts. Refer to paragraph 4–2*d*(2) for a general description of the tests.

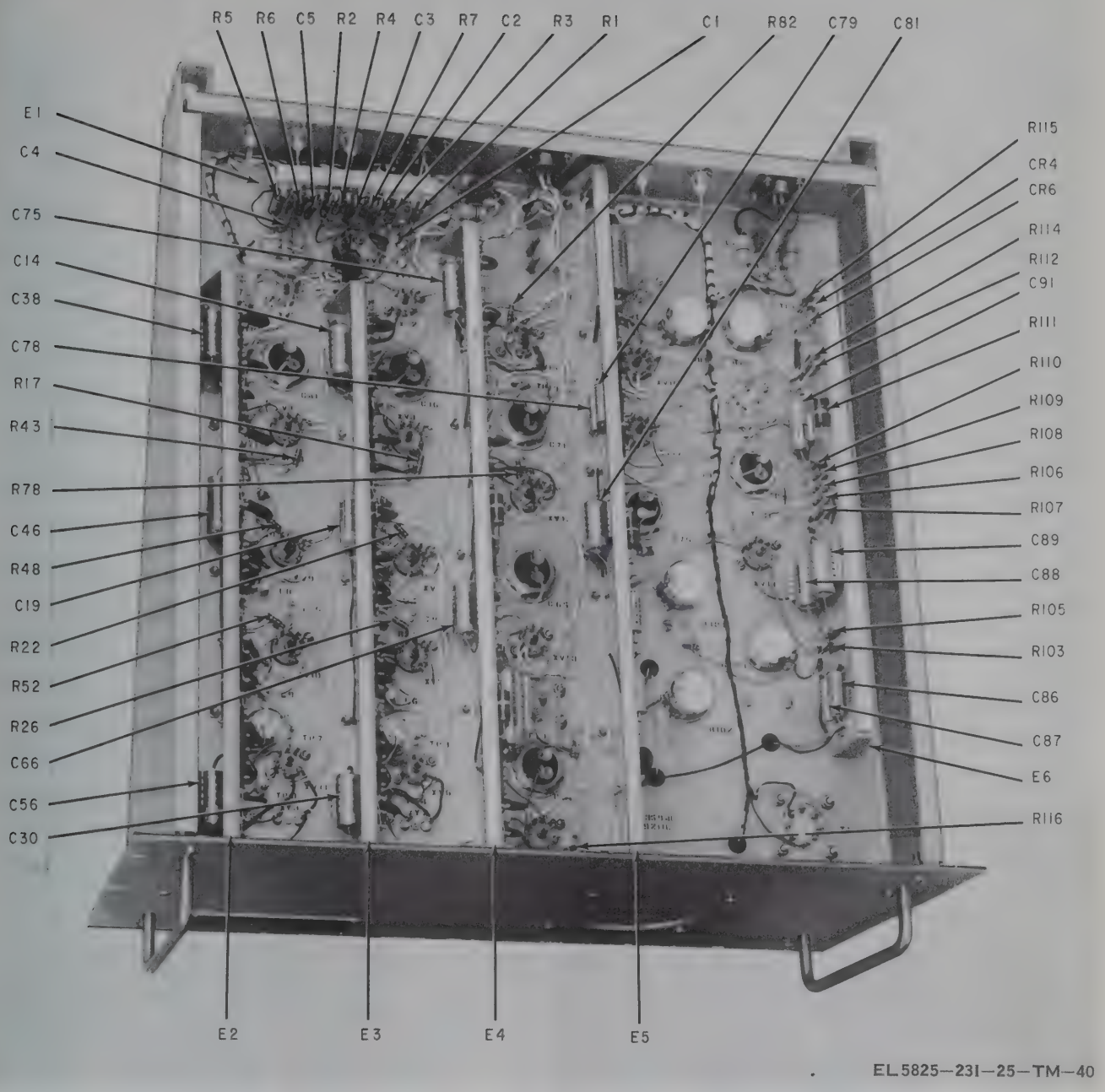


Figure 4-20. Rf detector, location of chassis components.

NOTE

Determining the existence of a possible short in the 6.3 volt filament wiring is difficult because of the low dc resistance of the transformer winding. Use visual check only at this point.

b. Bench Test Setup.

(1) Bench testing the azimuth indicator is required when interunit tests indicate that failure of system operation is caused by malfunction within the unit.

(2) The following test equipment is required. Refer to paragraph 4-3.

Federal stock No.	*Equipment*	*References*
6625-783-5965	Generator, Signal AN/URM-127	TM 11-6625-683-15
5825-918-6991	Amplifier, Electronic Control AM-3345/TRD	TM 11-5825-231-25
6625-911-6368	Counter, Electronic Digital Readout AN/USM-207	TM 11-6625-700-10
6625-913-9781	Multimeter ME-26B/U	TM 11-6625-200-15
5950-914-6807	Drive, Goniometer, Rotary Coupler TG-126(*)/TRD	TM 11-5825-231-25
6625-553-0142	Multimeter TS-352B/U	TM 11-6625-366-15
6625-228-2201	Oscilloscope AN/USM-281A	TM 11-6625-1703-15
5950-235-2086	Transformer, Variable, Power CN-16/U	

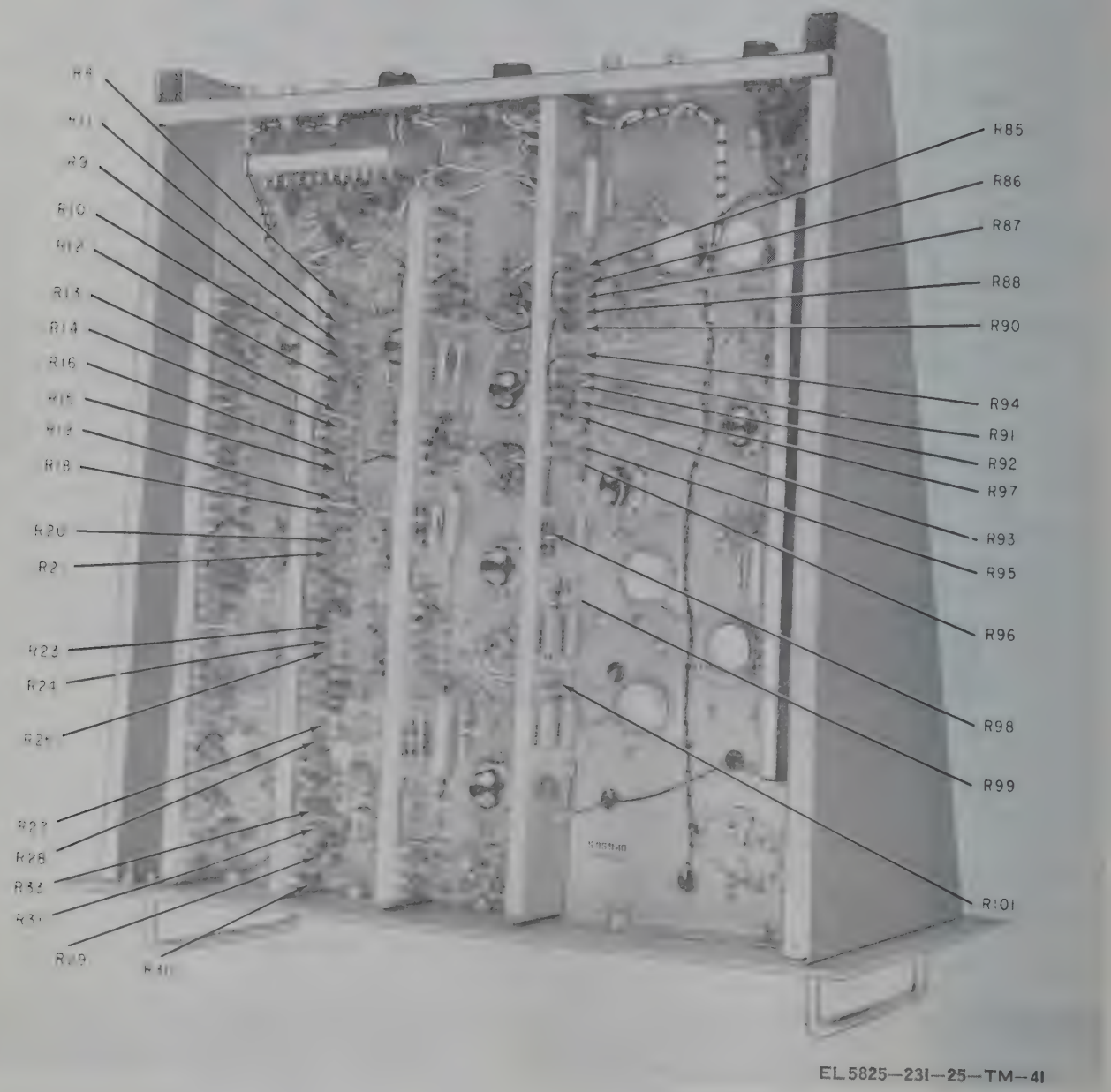


Figure 4-21. Rf detector, location of resistors, brackets E3 and E5.

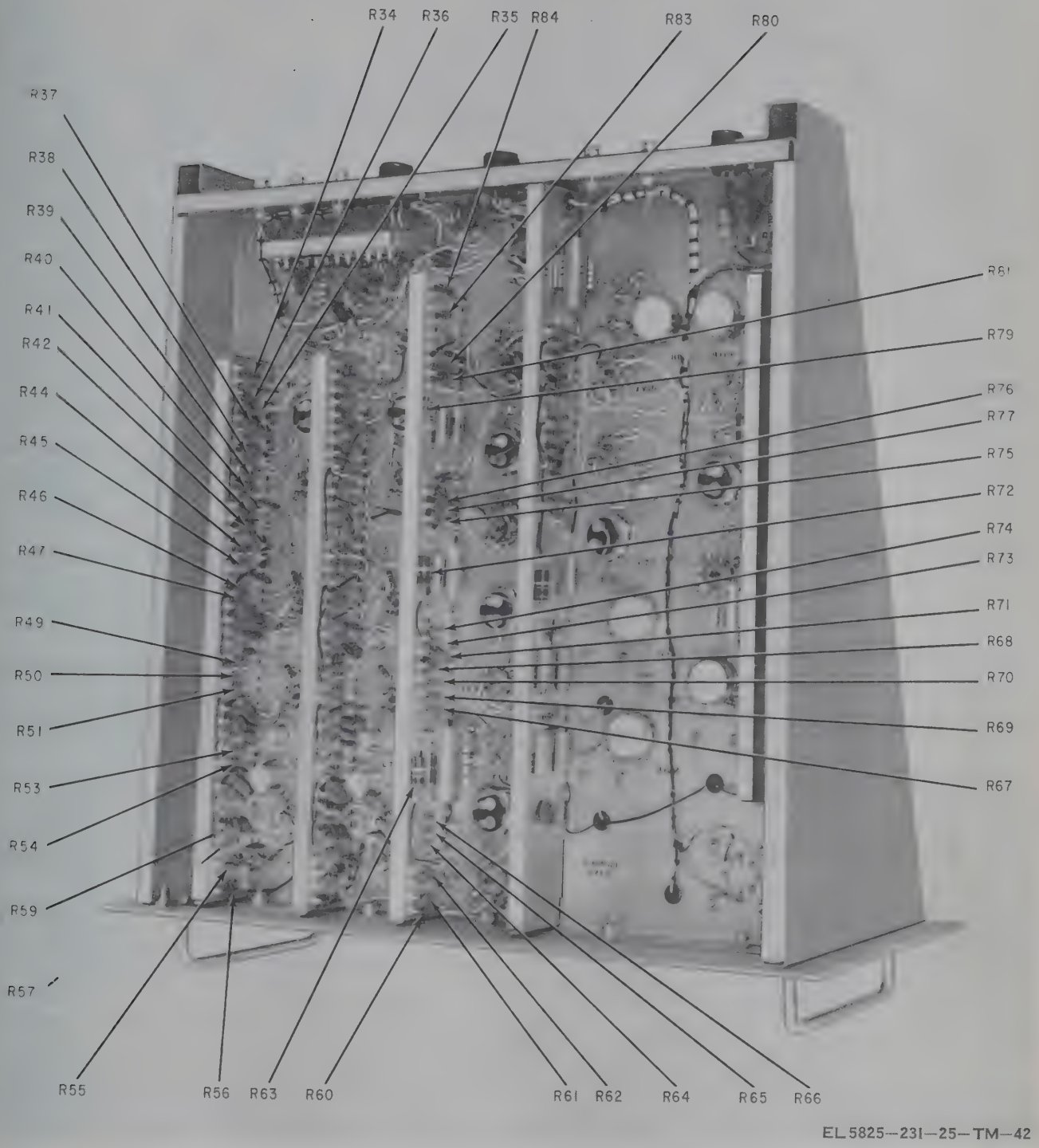


Figure 4-22. Rf detector, location of resistors, and brackets E1 and E3.

Chart 4-14. Troubleshooting—Power Supply

Item	Trouble	Probable cause	Remedy
1	No B+ voltage	*a.* Rectifier defective	*a.* Check V1.
		b. Filter shorted	*b.* Check C1.
		c. Regulator defective	*c.* Check V2.
		d. Power transformer defective	*d.* Check T1.
2	B+ voltage high or low	*a.* Output control misadjusted	*a.* Adjust R13.
		b. Regulator circuit defective	*b.* Check V2, V3, and V4.
3	Poor regulation	*a.* Regulator circuit defective	*a.* Check V2, V3, and V4.
		b. Open control resistor	*b.* Check R3.
		c. Open sensing network	*c.* Check R12, R13, and R14.
4	Filament voltage incorrect or absent.	Power transformer	Check T1.
5	Excessive hum	*a.* Hum control misadjusted	*a.* Adjust R2 for minimum hum (para 4-22).
		b. Sampling circuit defective	*b.* Check C2 and R2.
		c. No feedback	*c.* Check V3.

Chart 4-15. Short Circuit Tests—Azimuth Indicator

Test points	Resistance	Isolating procedure
Junction CR9 and C34 to ground (high-voltage power supply).	3 megohms.	A low resistance indicates: *a.* Breakdown of wiring insulation. Check all high-voltage wiring and components for possible short or arc-over to ground (chassis). *b.* Component failure. Check capacitors for leakage reresistance and diodes for proper front-to-back resistance ratios. Remove tube socket from crt to check for possible interelement tube short. Check transformer high voltage and filament winding for leakage to ground.
Junction R87 and C29 to ground (low-voltage power supply).	12,000 ohms.	A low resistance indicates: *a.* Breakdown of wiring insulation. Check the low-voltage B+ wiring for any evidence of shorting to ground. *b.* Component failure. Check capacitors for excessive leakage resistance (C29, C4) and dropping resistors for overheating.
Junction R61 and C31 (unregulated B+ line) to ground.	Infinite	A low resistance indicates: *a.* Breakdown of wiring insulation. Check the unregulated B+ wiring for any evidence of shorting to ground. *b.* Component failure. Check capacitor C31 for excessive leakage resistance. Check 5-volt filament winding of transformer for leakage resistance to ground.

(3) Connect test equipment as shown in figure 4-29.

(4) Set the equipment controls as follows:

Equipment	Control	Setting
Signal Generator AN/URM-127	FREQUENCY	90 Hz
	OUTPUT	3 volts (p-p)
Azimuth indicator	D.F. GAIN	Fully ccw
	SIZE	Fully ccw
	1 RCVR-2 RCVR	1 RCVR
	MONITOR-D.F.	DF
Oscilloscope	SWEEP	EXT. AC
	SWEEP FREQ.	1 msec/cm

c. Localizing Troubles. Perform the following tests to localize the malfunction to a section or stage in the circuit. Refer to the troubleshooting chart when a test fails. Refer to figures 4-31 through 4-34 for component locations.

(1) *Preliminary.* Turn on the indicator and adjust the line votage to 115 volts with the variac. Adjust the indicator controls to obtain a sharp spot in the center of the screen.

(2) *Alidade illumination.* Adjust the azimuth indicator DIMMER control for sufficient alidade illumination. Turn on the control amplifier.

(3) *Circular presentation.* Adjust the azimuth indicator SIZE and D.F. GAIN controls to obtain a circular presentation.

(4) *Df presentation.* Turn on the audio signal generator and adjust the frequency to minimize the rotation of the display. Adjust the azimuth indicator D.F. GAIN and SIZE controls for a half-propeller presentation which is free from ghosts, smears, or a secondary bearing indication.

(5) *Blanking sensitivity.* Rotate azimuth indicator D.F. GAIN control ccw, increasing the width of the half-propeller shaped pattern. No secondary pattern should appear while the shape of the primary pattern is still discernible.

(6) *72-kHz oscillator.* Connect the counter

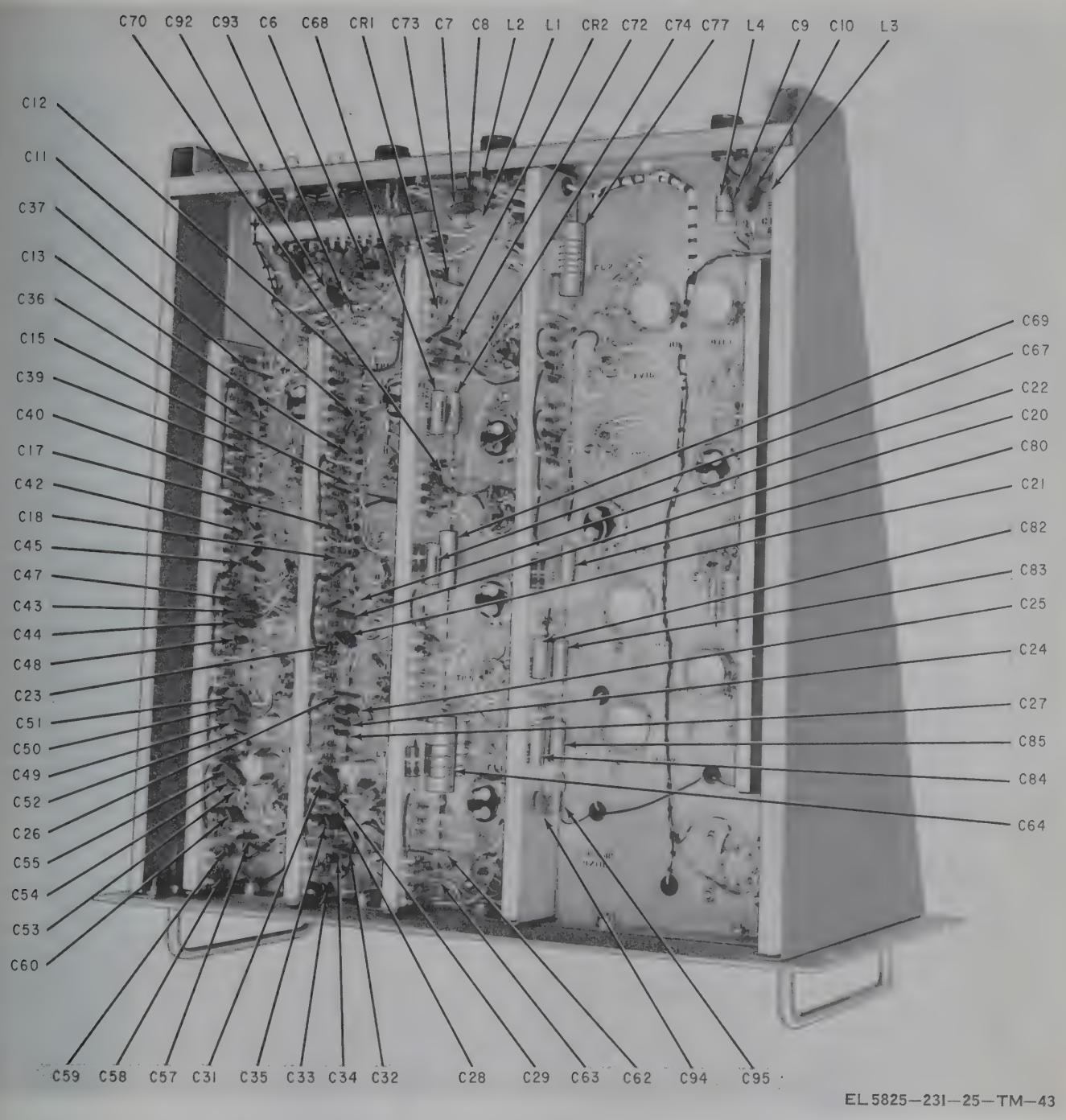


Figure 4–23. Rf detector, location of capacitors.

to V6, pin 3. Measure the oscillator output frequency as 72-kHz ±0.1. Disconnect counter.

(7) *Modulator output.* With the oscilloscope probe, observe the modulator output at J2 on the azimuth indicator. See figure 4–30 for waveforms.

(8) *Frequency doubler.* With the oscilloscope probe, observe the frequency doubler output at pin 1 of the modulator tube V2. See figure 4–30 for waveforms.

d. Isolating Troubles. If the previous tests have not uncovered the defective components, continue troubleshooting as follows:

(1) *Voltage/resistance measurements.* Make voltage and resistance measurements at the tube sockets in accordance with the voltage/resistance chart in figure FO–2.

(2) *Signal tracing.* Refer to the schematic diagram (fig. FO–5) and the unit function given in paragraph 2–11.

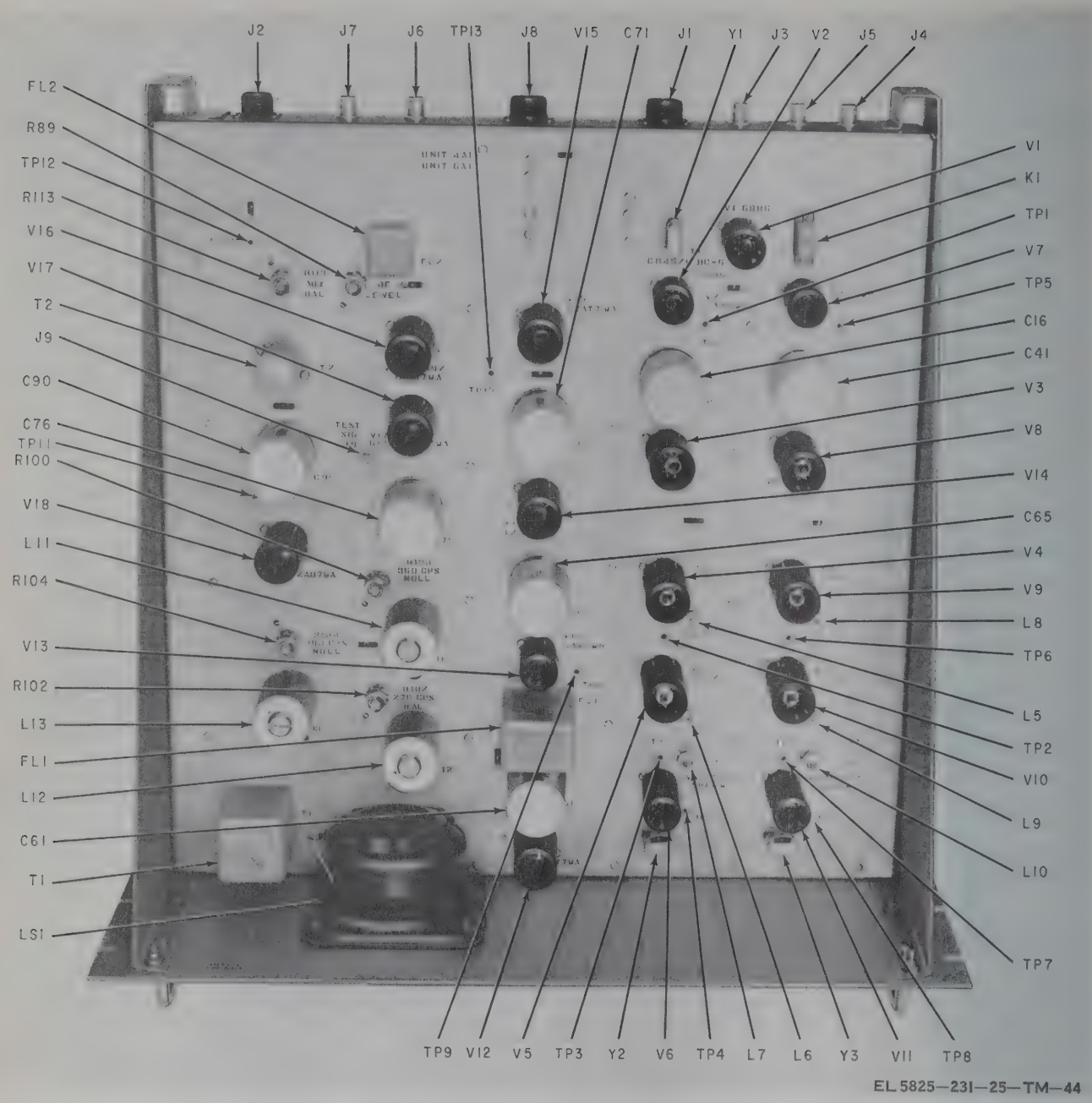


Figure 4-24. Rf detector, location of tubes and test points.

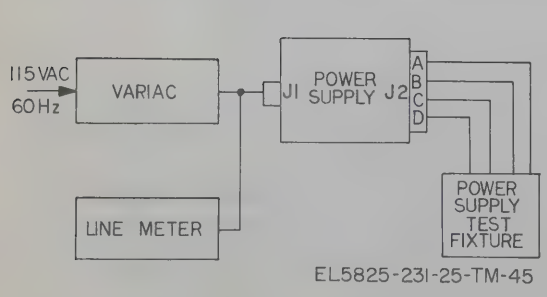


Figure 4-25. Test setup, power supply.

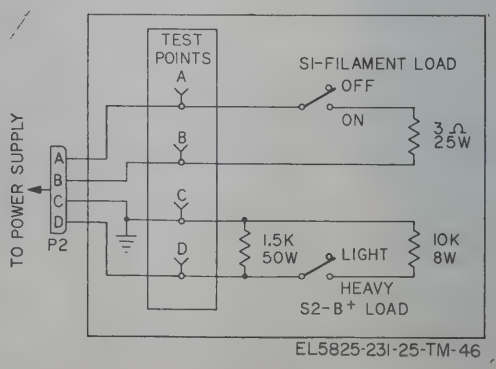


Figure 4-26. Test fixture, power supply.

Chart 4-16. Troubleshooting—Azimuth Indicator

Item	Trouble	Probable cause	Remedy
1	No alidade illumination	*a.* Defective fuse	*a.* Check F1, F2.
		b. Defective lamp	*b.* Check DS1 through DS4.
		c. Defective DIMMER control	*c.* Check R74.
2	No display	*a.* No power input	*a.* Check fuses F1, F2, F3.
		b. Defective low-voltage power supply.	*b.* Check for +275 vdc at pin 6 of V9. See item 8.
		c. Defective high-voltage power supply.	*c.* Check for 4,000 vdc at CR9, C34 junction. See item 9.
3	Dot only	*a.* Defective 72-kHz oscillator	*a.* Check V5, V6.
		b. Defective SIZE control	*b.* Check R33.
		c. Defective MONITOR-D.F. switch	*c.* Check S3.
		d. Defective modulator	*d.* Check V2.
		e. Defective amplifier	*e.* Check V3.
		f. Defective deflection circuit	*f.* Check circuitry associated with T4 and T5.
4	Cannot center display	*a.* Defective controls	*a.* Check R48, R49.
		b. Shorted capacitor	*b.* Check C27.
5	Poor focus	*a.* Defective control	*a.* Check R57.
		b. Defective divider	*b.* Check R51 through R60.
6	Circular display only	*a.* Defective D.F. GAIN control	*a.* Check R1.
		b. Defective amplifier	*b.* Check V1.
		c. Defective frequency doubler	*c.* Check CR1, CR2 and associated circuitry.
7	Full propeller display	*a.* Defective blanking circuit	*a.* Check V6, V7 and associated circuitry.
		b. Defective dc restorer	*b.* Check CR7.
8	No low voltage	*a.* Defective tube	*a.* Check V8–V11.
		b. Defective filter	*b.* Check C29, R87, C31.
9	No high voltage	*a.* Defective rectifier	*a.* Check CR8, CR9.
		b. Defective filter	*b.* Check C34, C35.
		c. Defective transformer	*c.* Check T9.
		d. Defective divider	*d.* Check R51–R60.
10	Excessive ripple on low voltage.	a. Defective filters	*a.* Check C29, C31.
		b. Defective hum balance circuit	*b.* Check R67, C32, and V10.
11	Poor half-propeller shape	*a.* Controls misadjusted	*a.* Check adjustment of R9 and R77. See Section IV.
		b. Defective modulator	*b.* Check V2.

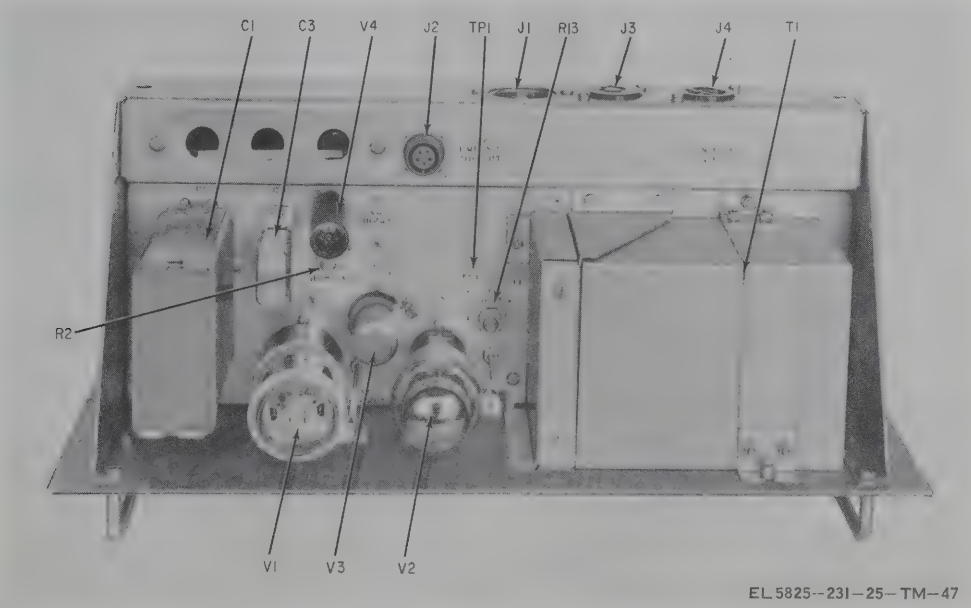


Figure 4-27. Power supply, top view.

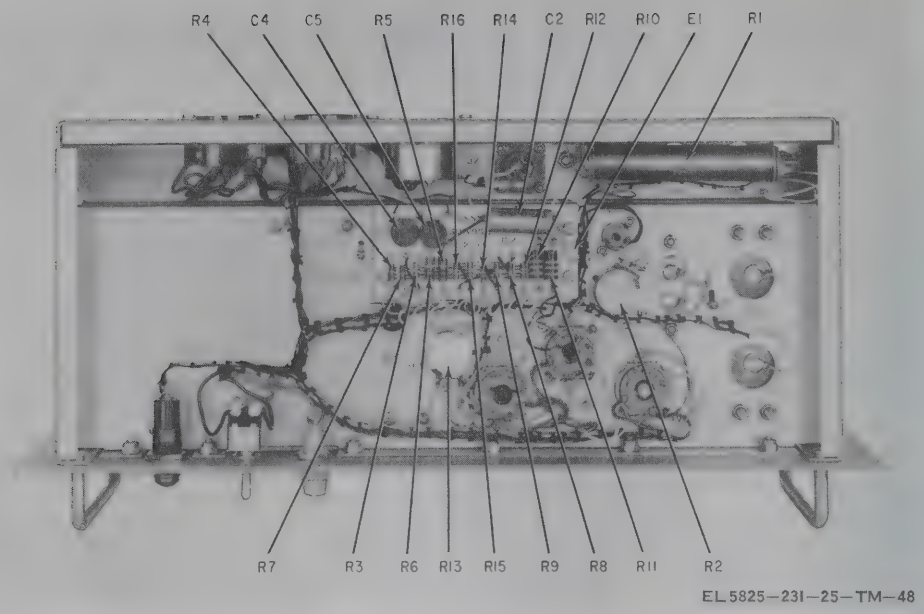


Figure 4-28. Power supply, bottom view.

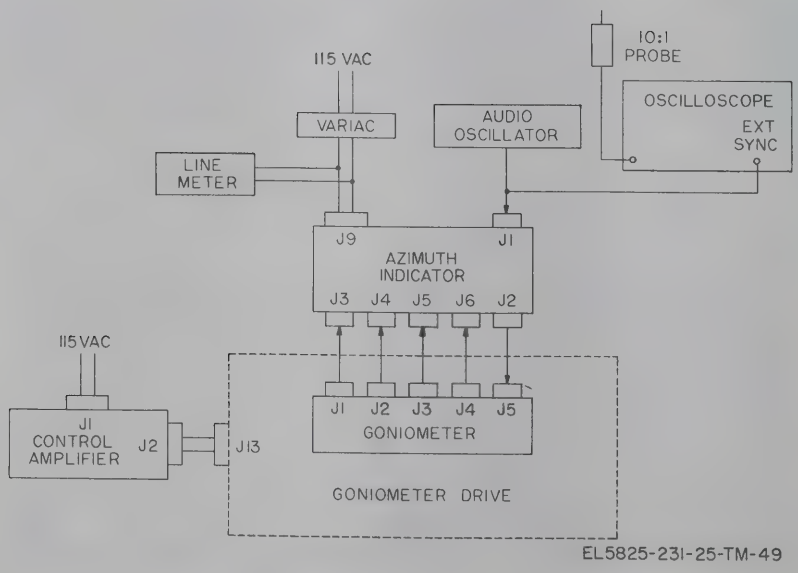


Figure 4-29. Test setup, azimuth indicator.

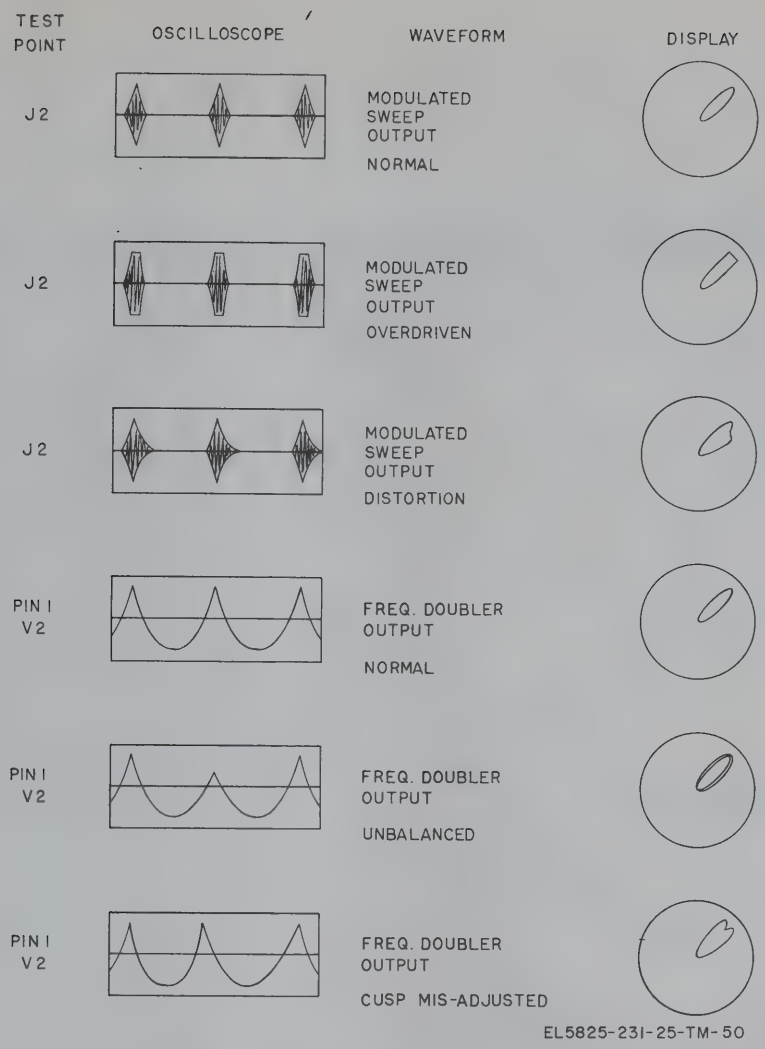


Figure 4–30. Waveforms, azimuth indicator.

4–12. Panel, Power Distribution SB–1747/TRD

a. General. Be extremely careful when preparing this unit for trouble-shooting because of the high power available. Before making any checks, disconnect 115 or 230 volt line. After disconnecting J1 or J2, as applicable, make a complete visual check to be sure that all connections are tight and proper, and switches S1 and S2 are off. See figures 4–35 and 4–36 for component locations.

b. Test Equipment. The only test equipment necessary to complete troubleshooting is the TS–352B/U. Probable troubles, causes, and remedy necessary to correct the malfunctions are listed in the troubleshooting chart (chart 4–17).

c. Frayed or Open Wires. Before applying power, check to see that no frayed or open wires are touching each other or the cover. Push in circuit breakers CB1 and CB2 and make sure J2 is plugged into the 115-volt ac line or J1 into the 230 line. If circuit breaker opens, reset once. If it opens again, do not reset until cause of overload is corrected.

d. Signal Tracing. Refer to the schematic diagram (fig. 6–6) for signal tracing.

4–13. Oscilloscope 120B

WARNING

Be extremely careful when trouble-shooting this unit because of the high voltages present.

NOTE

For troubleshooting procedures for the AN/USM–318(V)1, used in the AN/TRD–23A, refer to TM 11–6625–1703–15 and chapter 8.

a. Checking B+ and Filament Circuits for Shorts.

(1) Refer to paragraph 4–2*d*(1) for a general description of these tests.

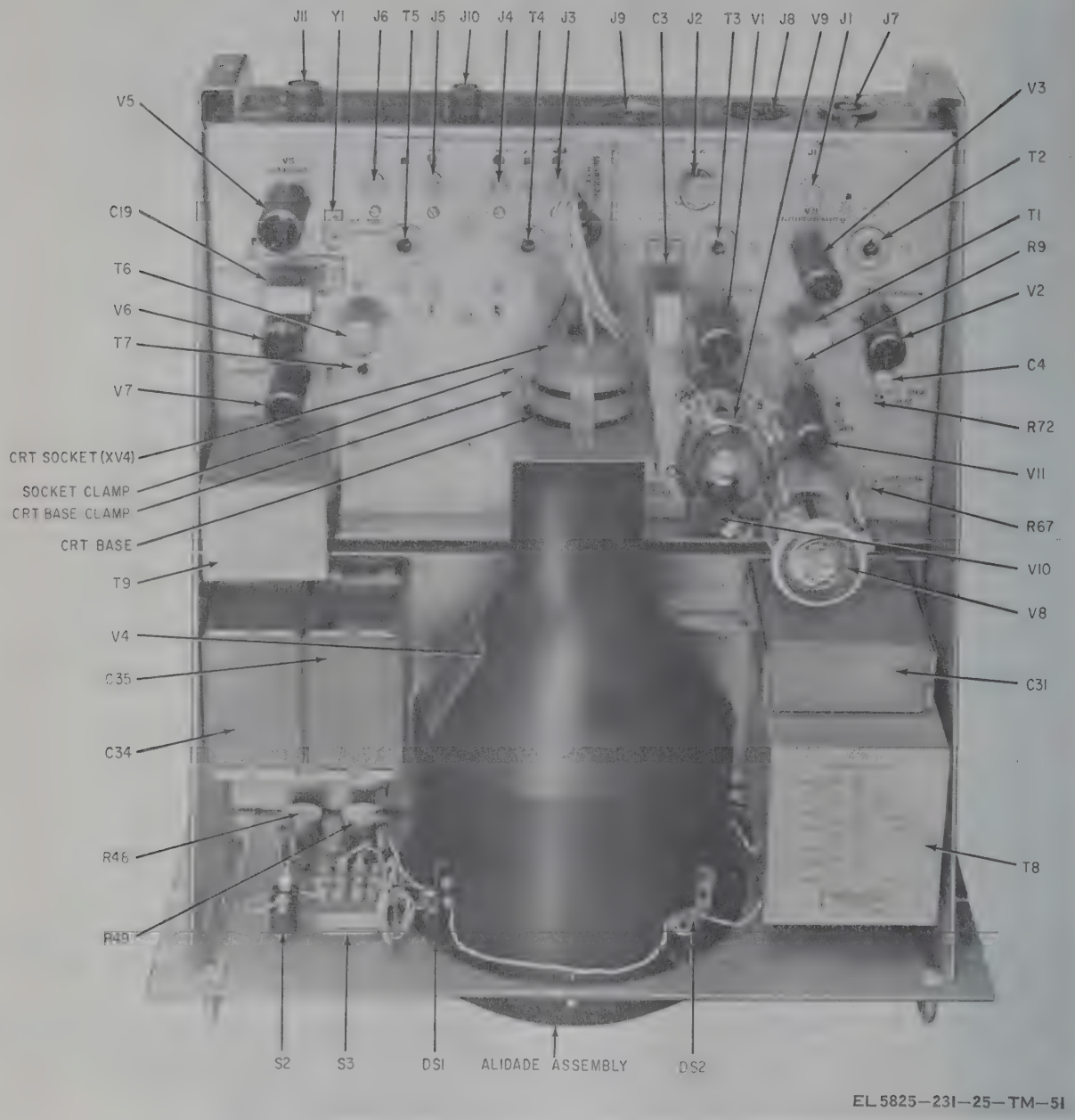


Figure 4-31. Azimuth indicator, top view.

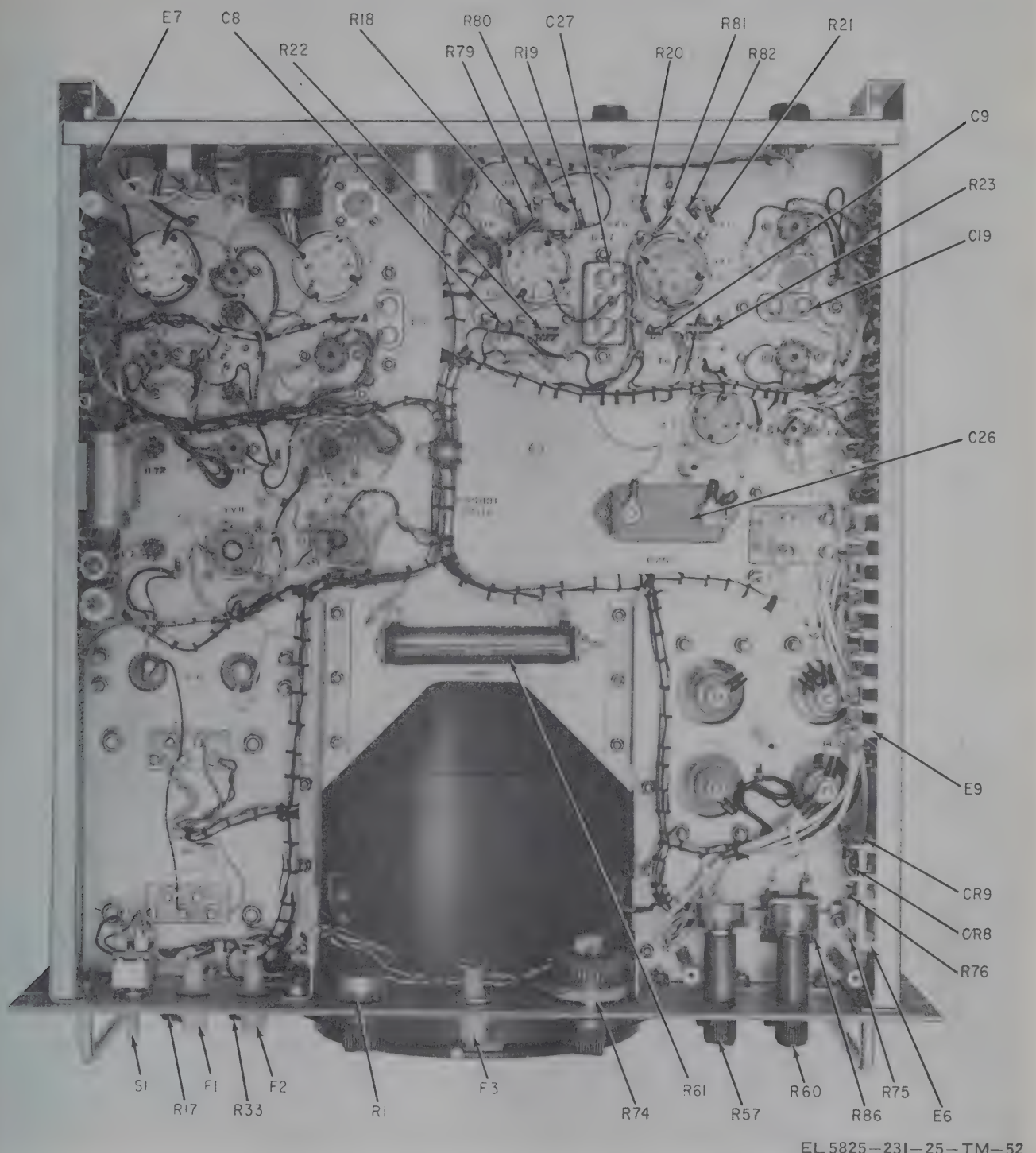


Figure 4-32. Azimuth indicator, bottom view.

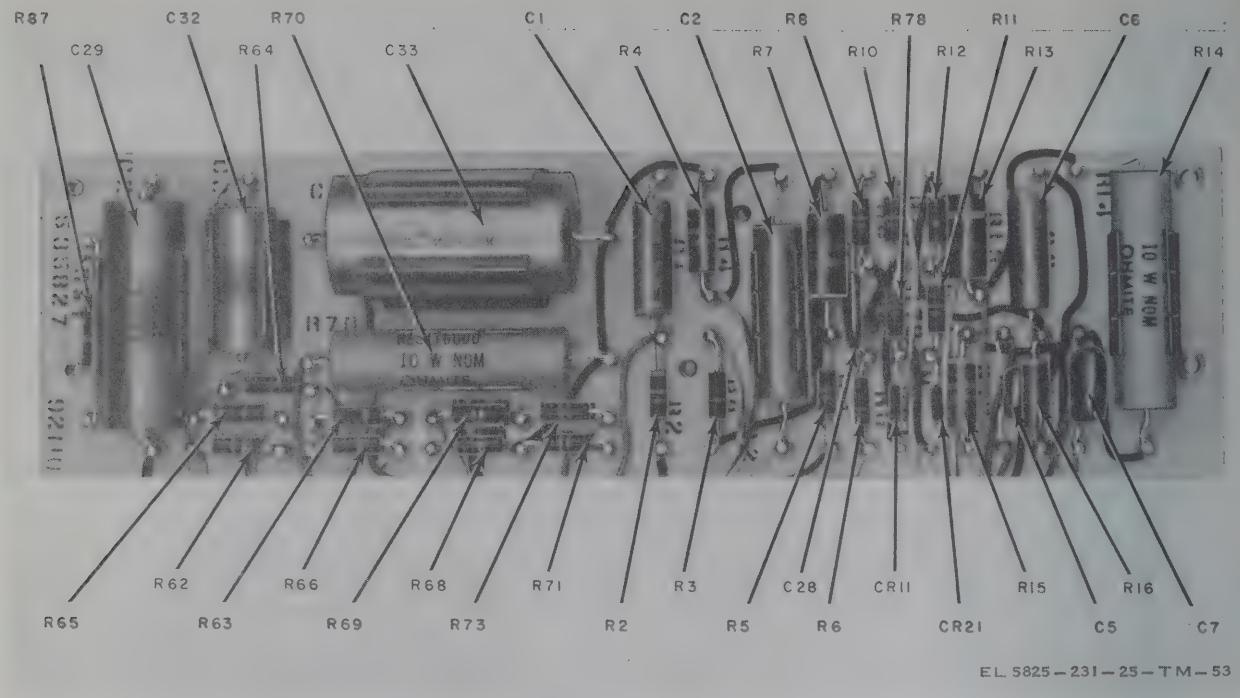


Figure 4-33. Azimuth indicator, component board E7.

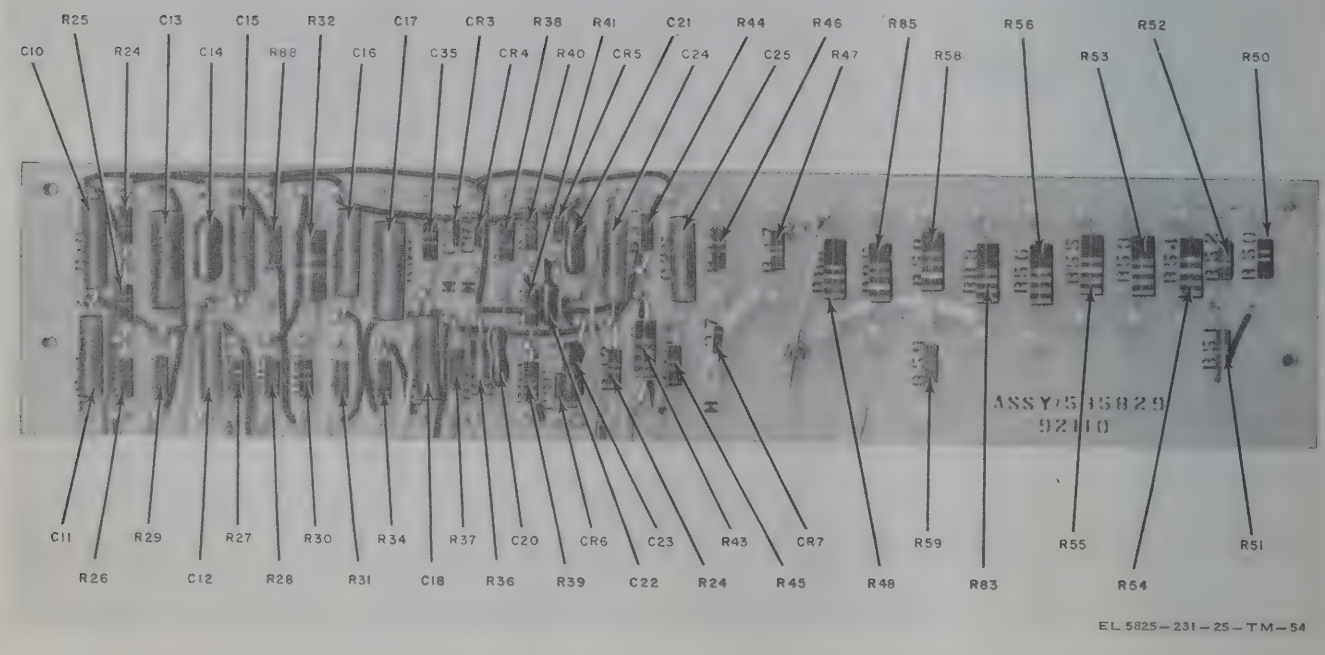


Figure 4-34. Azimuth indicator, component board E9.

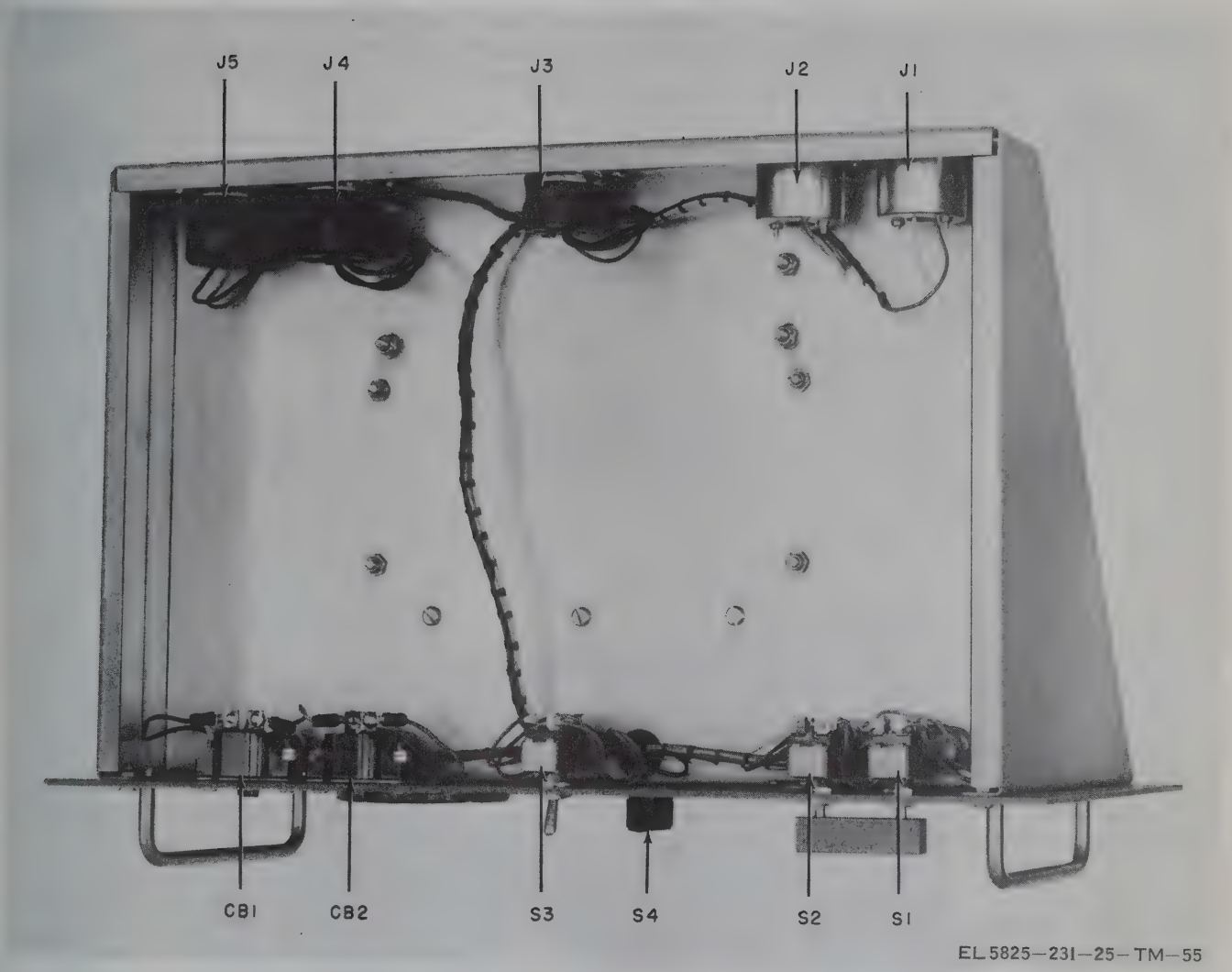


Figure 4-35. Power panel, bottom view.

Chart 4-17. Troubleshooting—Power Panel

Item	Trouble	Probable cause	Remedy
1	Meters M1 and M2 do not indicate voltage and frequency of power source.	*a.* Circuit breaker CB1 or CB2	*a.* Press CB1 or CB2 depending on whether using 115v or 230v.
		b. Defective switch contacts in S1 or S2.	*b.* Check switches.
		c. Defective meters, short circuit across output load.	*c.* Check meters. Locate short.
		d. Transformer T1 is open	*d.* Check transformer.
2	Normal meter readings are obtained with 115 vac power input to receptacle J2, but no voltage is indicated when a 230 vac power is connected to receptacle J1 (switch set at 230V position).	*a.* Circuit breaker CB1 is open	*a.* Press reset button CB1.
		b. Defective switch contact S1	*b.* Check switch contacts.
		c. Open transformer T1	*c.* Check transformer T1.
3	Normal meter readings are obtained with a 230 vac power input to receptacle J1, but no voltage is indicated when a 115 vac power input is connected to receptacle J2 (switch set at 115V position).	*a.* Circuit breaker CB2 is open	*a.* Press reset button CB2.
		b. Defective switch contacts S2	*b.* Check switch contacts.
		c. Open transformer T1	*c.* Check transformer T1.
4	OUTPUT VOLTAGE meter fluctuates.	*a.* Fluctuating input from source	*a.* Test input back to source.
		b. Defective input plugs J1, J2	*b.* Check plugs.
		c. Defective output receptacles J3, J4, J5.	*c.* Check receptacles.

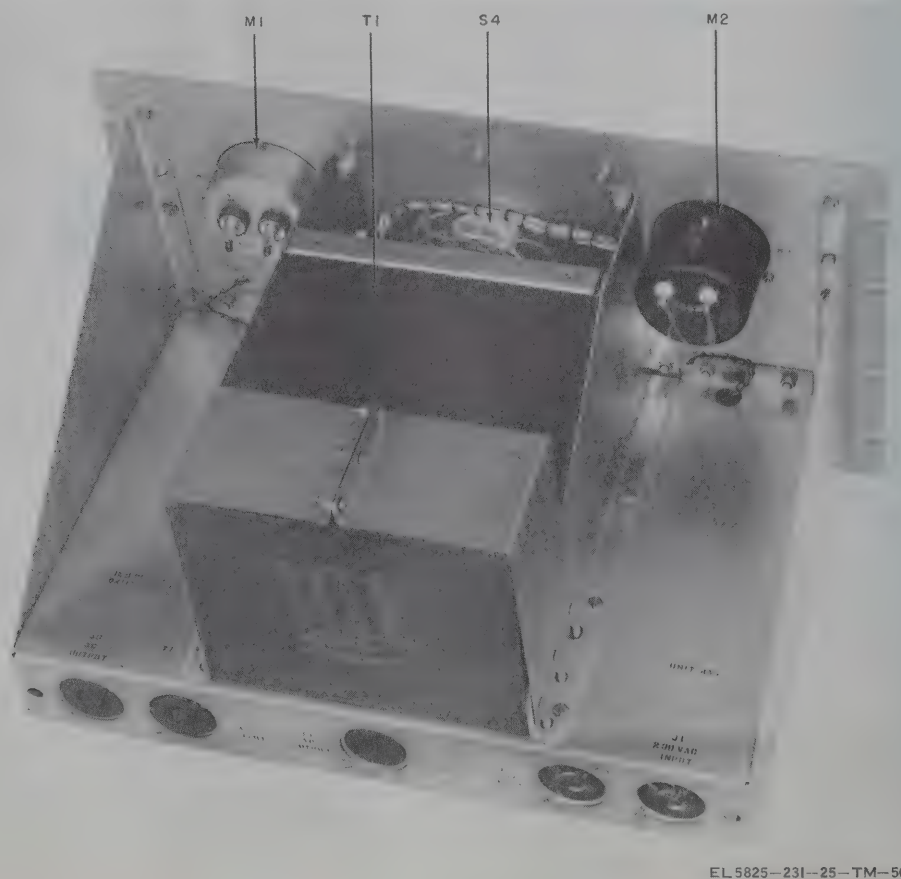


Figure 4-36. Power panel, top view.

(2) Set the oscilloscope controls as follows:

Control	*Setting*
INTENSITY/POWER	OFF
All other controls	Center position

Chart 4-18. Short Circuit Tests—Oscilloscope HP120B

Test points	*Resistance*	*Isolating procedure*
V308, pin 1	60K	Check V308, C322
V309, pin 9	8K	Check V309, C325
V311, pin 2	9K	Check R351, R352, R353

Federal stock No.	*Equipment*	*References*
6625-913-9781	Multimeter ME-26B/U	TM 11-6625-366-15
6625-228-2201	Oscilloscope AN/USM-281A	TM 11-6625-1703-15
6625-783-5965	Generator, Signal AN/URM-127	TM 11-6625-683-15

Equipment	*Control*	*Setting*
Signal Generator AN/URM-127	FREQUENCY	1 kHz
Oscilloscope 120B	VERTICAL:	
	SENSITIVITY	1 VOLTS/CM
	AC-DC	AC
	VERNIER	CAL
	HORIZONTAL:	
	DISPLAY	1 MSEC/CM
	SWEEP MAGNIFIER	X1
	AC-DC	AC
	TRIGGER	AUTO
	VERNIER	CAL

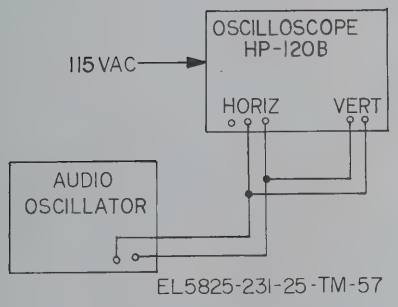


Figure 4-37. Test setup, monitor oscilloscope.

(3) Set the equipment controls as follows:

c. Localizing Troubles. Perform the following tests to localize the malfunction to a section or stage in the circuit. Refer to the trouble-shooting chart when a test fails. Figures 4-38 through 4-41 show component locations.

(1) *Preliminary.* Turn on the monitor oscilloscope and adjust the HORIZONTAL and VERTICAL POSITION controls to center the trace. Adjust FOCUS and INTENSITY controls for sharp, bright trace.

(2) *Vertical amplifier.* Turn on the AN/URM-127 and adjust the output for 1.75 volts on the ME-26B/U. Set the TRIGGER control to INT +, and adjust the TRIGGER LEVEL for a stable trace. The display should be 10 cycles of a sine wave with an amplitude of 5 volts peak-to-peak.

b. Bench Test Setup (fig. 4-37).

(1) Bench testing the monitor oscilloscope is required when tests indicate that failure is caused by a malfunction within the unit.

(2) The following test equipment is required. Refer to paragraph 4-3 for common names.

(3) *Horizontal amplifier.* Set the TRIGGER SOURCE control on the monitor oscilloscope to EXT, and the HORIZONTAL DISPLAY control to 1 VOLTS/CM. Observe a straight 45° line.

d. Isolating Troubles. If the previous tests have not uncovered the defective components, continue troubleshooting as follows:

(1) *Voltage/resistance measurements.* Make voltage and resistance measurements at the tube sockets in accordance with the voltage/resistance charts in figures 6-11 and 6-12.

(2) *Signal tracing.* Refer to the schematic diagrams (fig. FO-10 through FO-15) and the unit function in paragraph 2-13.

4-14. Transmitter, Radio T-279A/UR

a. Checking B+ and Filament Circuits for Shorts.

(1) Refer to paragraph 4-2*d*(1) for a general description of these tests.

(2) Disconnect batteries. Place TRANSMITTER switch to ON. Place CW-MCW switch to CW.

(3) All measurements are made on terminal board E602.

Chart 4–19. Troubleshooting—Oscilloscope 120B

Item	Trouble	Probable cause	Remedy
1	Nothing visible on crt with BEAM FINDER control pressed.	*a.* Low-voltage power supply	*a.* Check voltages and resistance in accordance with figures 6–11 and 6–12. If adjustment does not correct malfunction, substitute tubes and check remaining components in circuit until faulty component is discovered.
		b. Horizontal or vertical amplifier	*b.* Check plate voltages. Be sure HORIZONTAL and VERTICAL POSITION controls are centered, no signals applied, and HORIZONTAL DISPLAY switch set to external horizontal input. When discovering incorrect plate voltage, make detailed voltage check in that stage, referring to schematic diagrams FO–12, FO–10. Replace faulty component.
		c. Horizontal or vertical amplifier frequency response.	*c.* Check tubes by substitution, then trimmer, bypass and neutralizing capacitors, and replace faulty part.
		d. High-voltage power supply or faulty crt. **Warning** Be careful when measuring high voltage. Use proper equipment for high-voltage measurements.	*d.* Measure voltage to crt, and replace crt if voltage is normal. Refer to high-voltage power supply schematic diagram (fig. FO–14.) If high voltages are not present, check to see that oscillator V302 is oscillating. Note that faulty crt cathode supply affects grid supply, but crt grid supply has no effect on cathode supply. If both are excessively low or high, make voltage checks on V301 and determine faulty component.
2	Vertical sensitivity out of tolerance on all sensitivity ranges but horizontal sweep normal.	Vertical amplifier	Check V4, V5, C14, R52, and R55 and replace if defective. See figure FO–12.
3	Vertical sensitivity out of tolerance on one range.	VERTICAL SENSITIVITY switch S2 defective.	Check and replace S2 if defective. If not, check connections.
4	External horizontal sensitivity out of tolerance, but vertical sensitivity normal.	Horizontal amplifier	Check components of V101 and V102 and replace defective parts. To check tubes, substitute with known good tubes. See figure FO–10.
5	Faulty sweep; external horizontal deflection normal.	a. Sweep generator	*a.* A failure in any stage of the sweep generator will indicate abnormal waveforms in all stages. Check voltages of each stage to find failure.
		b. Defective switch contacts in S1 or S2.	*b.* Replace switch.
		c. Defective meters, or short circuit across output load.	*c.* Replace defective meters. Locate short and repair.
		d. Transformer T1 is open	*d.* Replace transformer.
6	Normal meter readings are obtained with 115 vac power input to receptacle J2, but no voltage is indicated when a 230 vac power is connected to receptacle J1 (switch set at 230V position).	*a.* Circuit breaker CB1 is open	*a.* Press reset button CB1.
		b. Defective switch contacts on S1	*b.* Replace switch.
		c. Open transformer T1	*c.* Replace transformer T1.

Item	Trouble	Probable cause	Remedy
7	Normal meter readings are obtained with a 230 vac power input to receptacle J1, but no voltage is indicated when a 115 vac power input is connected to receptacle J2 (switch set at 115V position).	*a.* Circuit breaker CB2 is open ----	*a.* Press reset button CB2.
		b. Defective switch contacts on S2 --	*b.* Replace switch.
		c. Open transformer T1 ----------	*c.* Replace transformer T1.
8	Voltmeter fluctuates ----------	*a.* Fluctuating input from source --	*a.* Test input line to source.
		b. Defective input plugs J1 and J2 --	*b.* Replace plugs.
		c. Defective output receptacle J3, J4, or J5.	*c.* Replace receptacles.

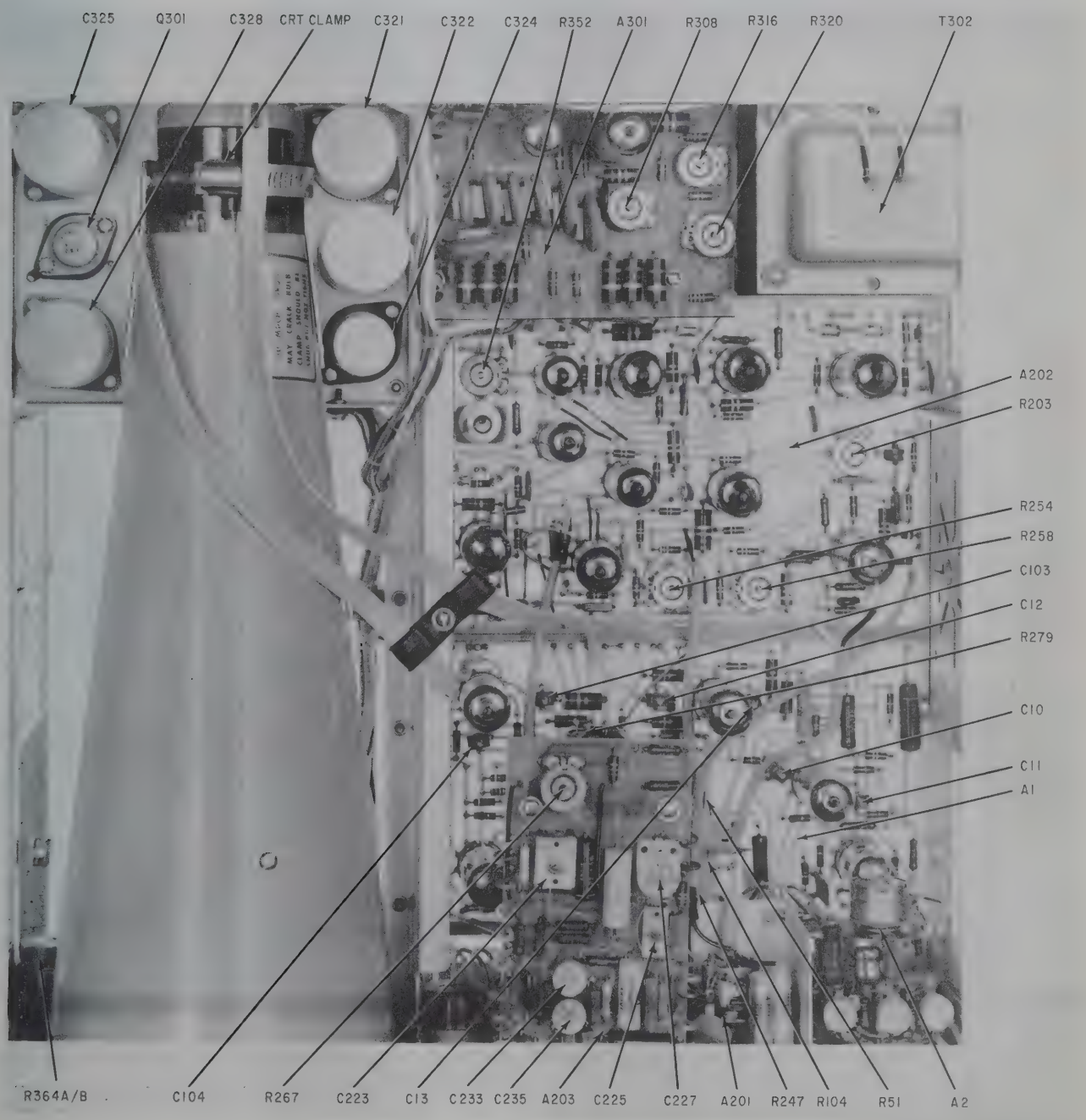


Figure 4-38. Oscilloscope 120B, top view.

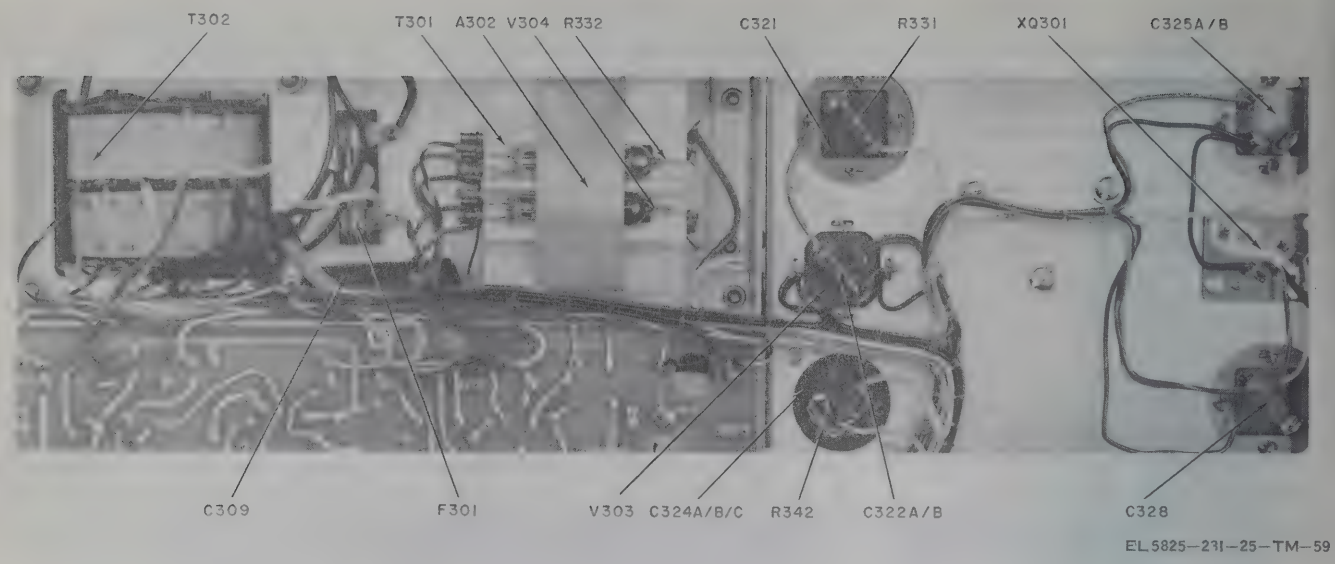


Figure 4-39. Oscilloscope 120B, hv power supply.

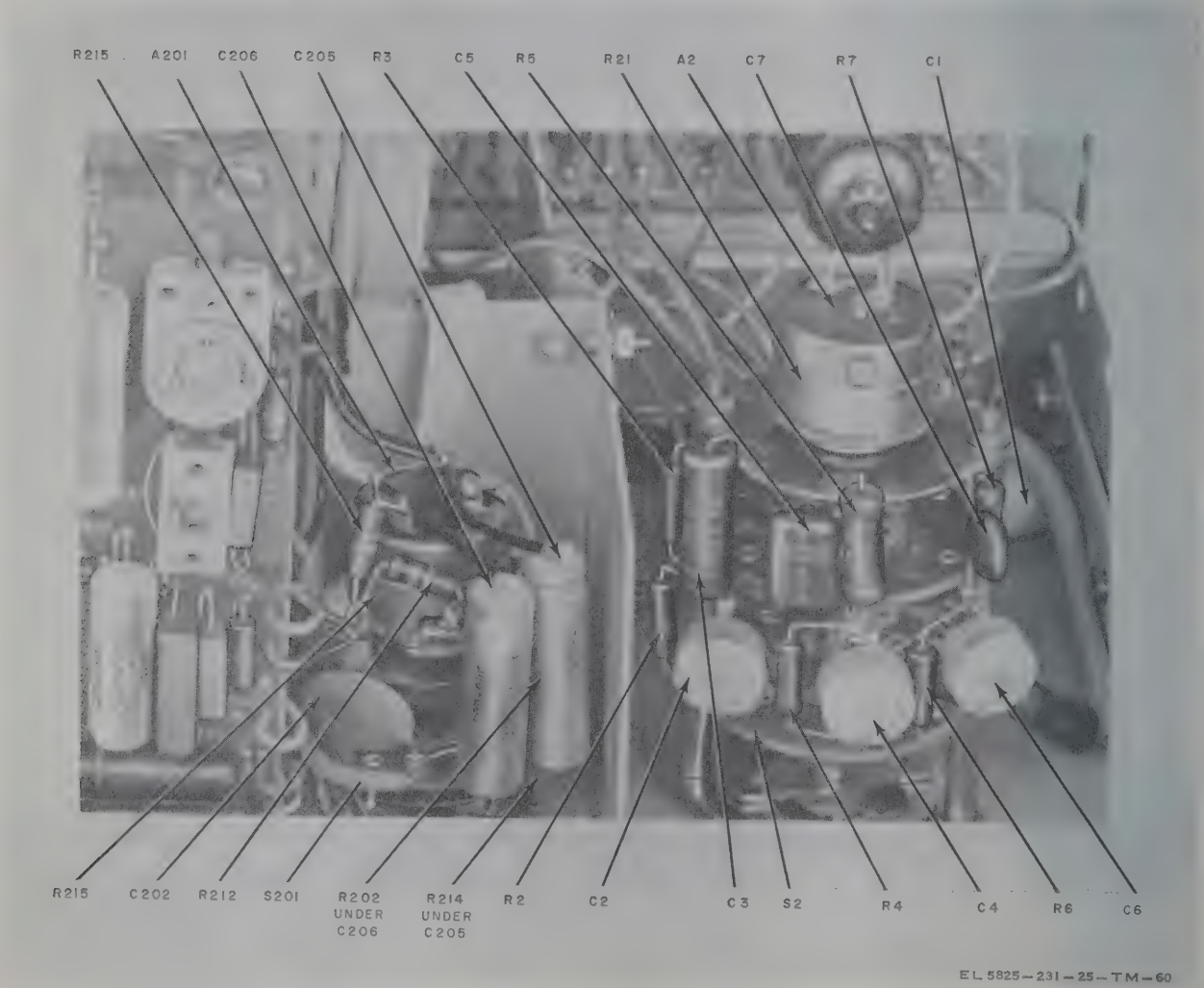


Figure 4-40. Oscilloscope 120B, vertical components.

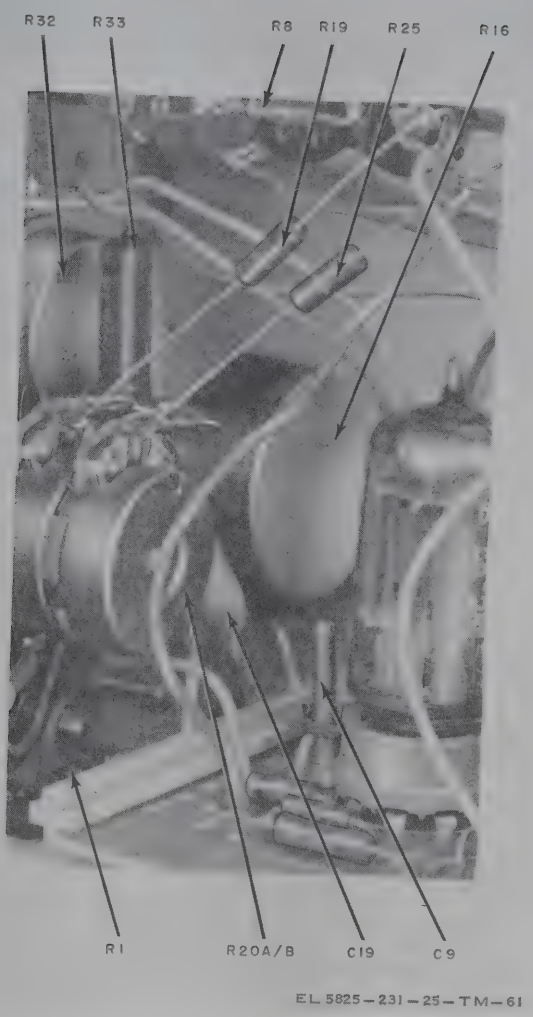


Figure 4-41. Oscilloscope 120B, right side view.

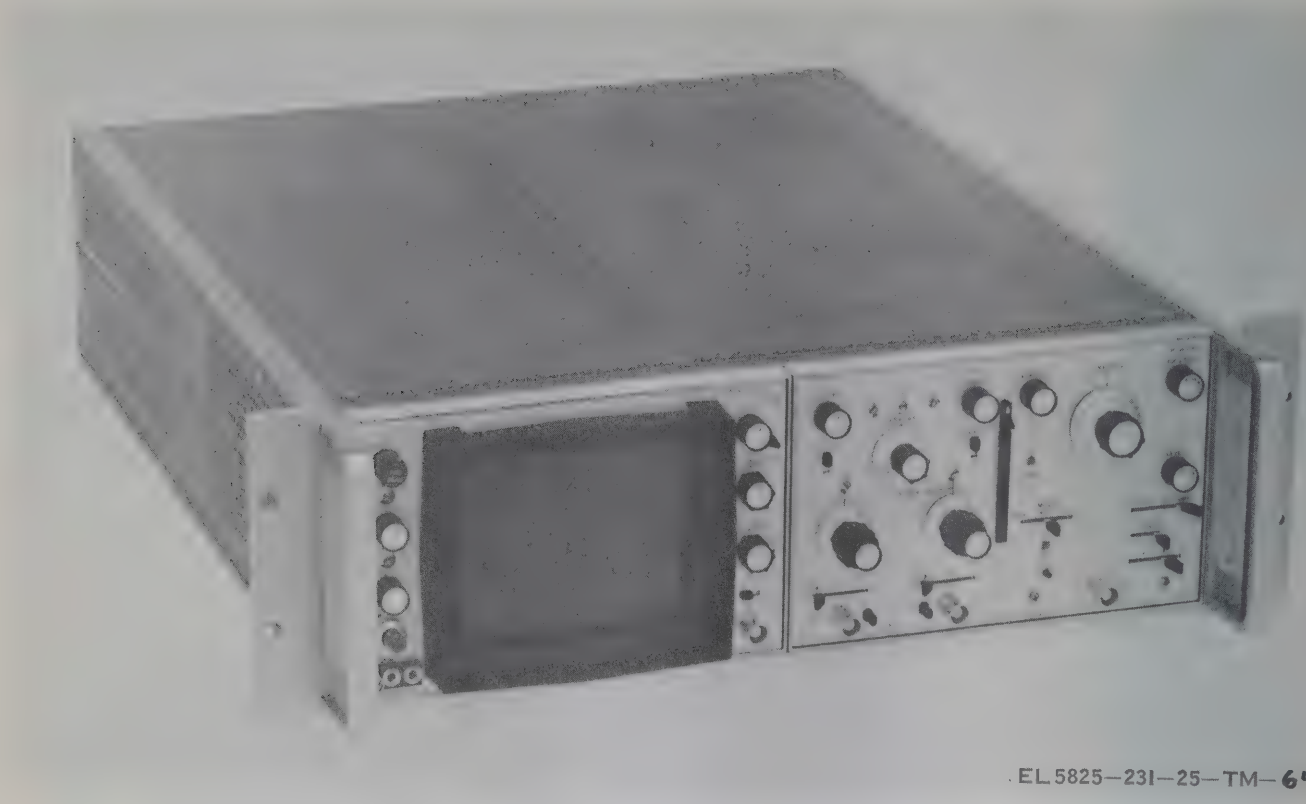


Figure 4-42. Oscilloscope AN/USM-318(V)1.

Chart 4-20. Short Circuit Tests—Target Transmitter

Test point	*Resistance*	*Isolating procedure*
Pin 1	Infinite	Check R604, C610, C617.
Pin 2	Infinite	Check C604, C615.
Pin 3	Infinite	Check V603, R612, C614.
Pin 4	1.5 ohms	Check tube filaments.

b. Bench Test Setup.

(1) Bench testing the target transmitter is required when tests indicate that failure of the unit is caused by a malfunction within the unit.

(2) The following test equipment is required. Refer to paragraph 4-3 for common names.

Federal stock No.	*Equipment*	*References*
5820-069-8915	Radio Receiver R-725/URR	TM 11-5825-231-25
6625-553-0142	Multimeter TS-352B/U	TM 11-6625-366-15

(3) Set the transmitter controls as follows.

Control	*Setting*
OUTPUT	Fully ccw
BANDSWITCH	.5-1mc
TUNING	Center of range
CW-MCW	MCW
TRANSMITTER	OFF

c. Localizing Troubles. Perform the following tests to localize the malfunction to a section or a stage in the circuit. Refer to the trouble-shooting chart when a test fails. Figures 4-42 and 4-43 and 4-44 show component locations.

(1) *Preliminary.* Tie a test lead to the whip antenna of the target transmitter and connect it to J103 of the radio receiver.

(2) *Transmitter output.* Turn on the transmitter, advance the OUTPUT control slightly, and tune the receiver for maximum signal on the CARRIER LEVEL meter. Adjust the transmitter OUTPUT control for sufficient signal to make the receiver easy.

(3) *Band check.* Rotate the transmitter BANDSWITCH through its entire range, returning the receiver, as required, for maximum signal.

(4) *Modulator check.* The output of the modulator should be visible as jumps on the receiver CARRIER LEVEL meter.

Chart 4-21. Troubleshooting—Target Transmitter

Item	Trouble	Probable cause	Remedy
1	Flashing INDICATOR lamp does not light.	*a.* Dead batteries	*a.* Check batteries, and replace if below standard.
		b. Dirty lamp socket contacts	*b.* Inspect contacts and clean.
		c. High humidity	*c.* Disregard if transmitter functions otherwise.
2	No output signal on all bands	*a.* Dead batteries	*a.* Check batteries, and replace if below standard.
		b. Defective oscillator or amplifier tube (3A5 or 3A4).	*b.* Replace tube.
		c. Defective BANDSWITCH S603	*c.* Repair or change BANDSWITCH.
		d. Tuning capacitor C601 or C602 shorted by foreign matter or bent plates.	*d.* Repair or replace capacitor. Align after this operation.
3	No output signal on one band	*a.* Defective BANDSWITCH contact.	*a.* Repair or replace switch.
		b. Defective coil	*b.* Test coil of dead band. Repair or replace and align.
4	No mcw signal	*a.* Defective tube (1R5)	*a.* Replace tube.
		b. Defective switch (S602)	*b.* Replace switch.
5	Intermitten operation	*a.* Poor connections	*a.* Inspect and repair.
		b. Noisy tube	*b.* Check tubes; replace if necessary.
		c. Defective contacts in BANDSWITCH S603.	*c.* Inspect contacts; clean or repair switch.
6	Weak output signal or increase OUTPUT control inoperative.	*a.* Weak batteries	*a.* Check batteries and replace if below standard.
		b. Defective amplifier tube (3A4)	*b.* Replace tube.
		c. Defective potentiometer (R609)	*c.* Check resistance at maximum-positions.
7	Frequency calibration incorrect or varries.	*a.* Dirty BANDSWITCH (S603) contacts.	*a.* Clean BANDSWITCH contacts.
		b. Dial drive mechanism or shaft couplin setscrews loose.	*b.* Tighten setscrews.
		c. Incorrect adjustment or alignment of coils.	*c.* Refer to paragraph 4-31.

d. Isolating Troubles. If the previous tests have not uncovered the defective components, continue troubleshooting as follows:

(1) *Voltage/resistance measurements.* Make voltage and resistance measurements at the tube sockets in accordance with the voltage/resistance chart in figure 6-8 and in the chart below.

Chart 4-22. Target Transmitter—Dc Resistance of Coils

Coil	Terminal	Ohms
L601	Across ends of coil	5.0
L602	Across ends of coil	2.2
L603	Across ends of coil	.8
L604	Across ends of coil	Less than 1
L605	Across ends of coil	Less than 1
L606	Across ends of coil	Less than 1
L607	Across ends of coil	7.8
L608	Across ends of coil	2.8
L609	Across ends of coil	.8
L610	Across ends of coil	Less than 1
L611	Across ends of coil	Less than 1
L612	Across ends of coil	Less than 1
L613	Across ends of coil	25

(2) *Signal tracing.* Refer to schematic diagram (fig. 6-7) and the unit functioning (para 2-14) as aids to signal tracing.

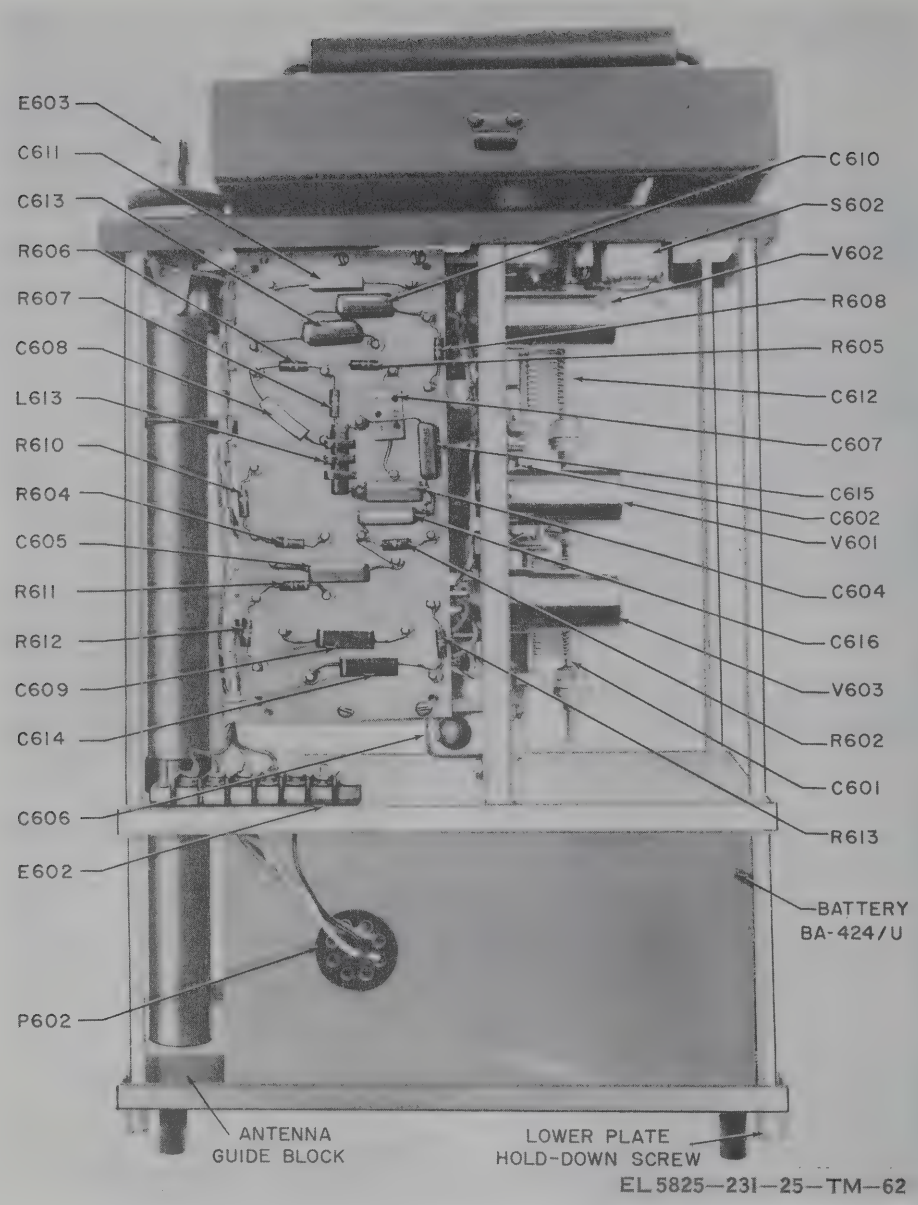


Figure 4-43. Target transmitter, front view.

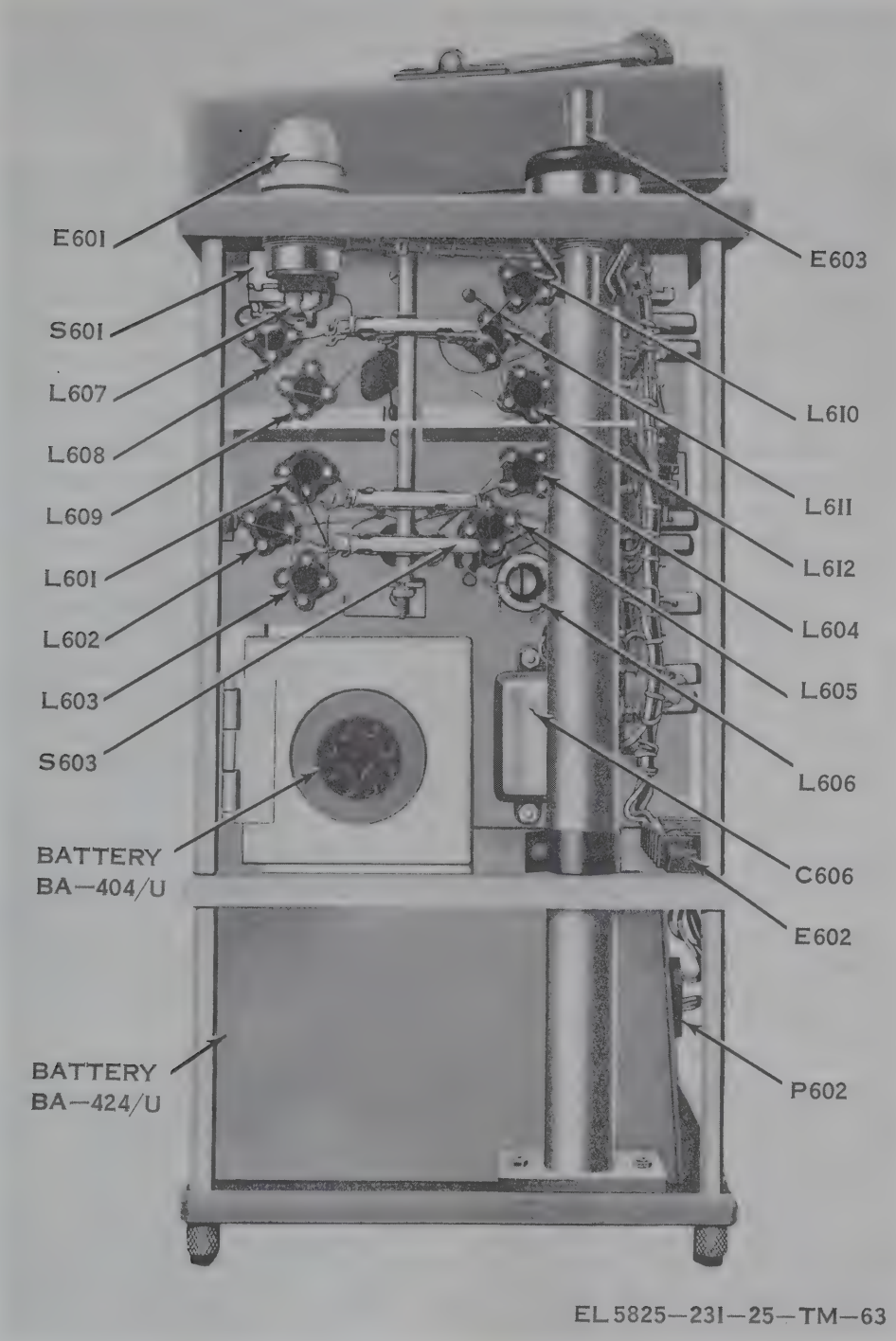


Figure 4–44. Target transmitter, left side view.

Section III. REPAIRS AND PARTS REPLACEMENT

4–15. General

Most of the parts in units of the direction finder set can be easily reached and replaced without special procedures. The precautions and special instructions for specific units should be read before attempting repairs or parts replacement.

4–16. Antenna Coupler

a. General Component Replacement. Components on printed circuit boards are replaced by conventional techniques. If leads have been bent over on the solder side, the component leads should be snipped and the leads pushed through the

board with an appropriate tool. If leads are not bent over, the component may be removed from the top of the board without clipping leads. Minimum heat should always be used for removal of small components.

b. Transistor or Transformer Replacement. To replace transistors or transformers on A1 and A2, the printed circuit assemblies must be raised from the chassis. This is accomplished by removing four screws from each side of board which goes through the chassis. Also the two 10–32 nuts which hold the transistor to the chassis must be removed. On A1, the rf cables should be disconnected. Normally, enough slack exists on rf cables and power leads to allow the boards to be raised to a point that permits access to the dip solder side. Transistors are removed by heating the three connections on the top of the board and pulling. This should be done carefully to prevent damage to the printed circuit board.

CAUTION

Never use a solder gun for transistor replacement. When replacing power transistors which are insulated from a heat sink with mica spacer insulation and teflon bushings, always save the mica spacer and bushings to use on the replacement transistor. Clean surface of heat sink and of the power transistor before installation. Inspect for scratches or dents or bends on the transistor surface. Do not use a transistor which fails to make a good heat transfer connection with the heat sink. When tightening a power transistor to the heat sink, make certain that the mounting nuts are not tightened excessively; mica insulation may crack.

WARNING

Never operate equipment with power transistor tack-soldered to its circuit. Lack of heat sink will destroy transistor in seconds. Use the substitution method of troubleshooting power transistor unless complete heat sinking is used.

c. Reassembly. Reassembly is accomplished by reversing the disassembly procedure. Before the through screws are tightened, be sure that notches on edges of the printed circuit board are clear of the tapped holes in the spacer bars. Nuts on transistors should be tight enough to insure a good heat transfer to the heat sink but not tight enough to crack the mica insulation if used.

4–17. Goniometer Drive

a. General. Disassembly and repair of the goniometer drive unit is a highly complex operation, and should be attempted only by well qualified personnel with the proper tools and equipment.

b. Special Tools Required. A goniometer spacing tool (locally fabricated) (SCA–T3908) is required to reassemble and center the goniometer stator.

c. Disassembly of Goniometer (fig. 6–1).

(1) Remove three screws from the mounting holes (10) in goniometer shaft retaining plate (9). Retaining plate, shaft bearing (11), and rotor assembly (8) are removed as a unit.

NOTE

To remove the unit, insert wood dowel into housing endhole against shaft center, and rap dowel with hammer to loosen assembly for removal.

(2) Tap out rotor assembly (8) from shaft bearing (11) in retaining plate (9).

(3) Remove spring washer (5) which prevents goniometer rotor from binding on rear of goniometer housing (1).

(4) Replace new goniometer shaft (12) rotor in shaft bearing (11).

NOTE

Rotor is not repairable; entire rotor must be replaced if defective. Test by substitution if coils are not open when checked with a multimeter. They would measure less than 1 ohm; therefore, it is not practical to check for shorted coils.

CAUTION

Do not disassemble the goniometer further unless goniometer spacing tool, SCA–T3908 is available to enable accurate centering of the goniometer stator in the goniometer housing. The goniometer rotor assembly rotor must be accurately spaced for proper rotation in the stators. If the tool is available for this spacing operation upon reassembly of the goniometer, the rest of the steps can be performed to replace either one or both stator coils. If spacing tool is not available, replace the goniometer housing, goniometer stator, and T1 coupling coil stator as a unit.

(5) If no further tear down of the goniometer is required, reassemble goniometer by reversing sequence to the disassembly procedure.

(6) To continue disassembly, remove the six

screws from the goniometer sideplate mounting holes (28, fig. 6–2).

(7) Tag uninsulated wire leads (for identification on replacement) that connect to J1, J2, J3, J4, and J5. Unsolder at jack connector terminals.

(8) Remove six screws holding top cover plate (32) of goniometer to housing and remove plate.

(9) Unsolder tagged wire leads from goniometer stator (29) and coupling coil (30) T1. Leads are visible inside goniometer housing. (Do not take leads off coupling coil if T1, coupling stator, is not replaced.)

(10) Remove two screws holding ground posts to inside wall of goniometer housing. This action disconnects black wire ground leads from stator to housing.

(11) Remove three goniometer stator mounting screws (27). One is located at bottom center of goniometer housing; the other two are located on inside center brackets exactly 4 inches behind the mounting slots. These screws hold the goniometer stator in fixed position.

(12) Loosen three goniometer stator adjusting setscrews (25); one is located at bottom center of goniometer housing; the other two are located on center brackets inside goniometer housing 1 3/4 inches behind the mounting slots.

(13) Remove goniometer stator (29) through front of housing.

(14) To remove stator of T1 (30), remove three screws in mounting face of stator attaching it to inside rear of goniometer housing. Insert a long screwdriver in the front opening of the goniometer housing to reach these screws.

(15) Remove T1 stator and replace.

d. Reassembly of Goniometer (fig. 6–2).

(1) Resolder leads to T1 stator (30) in rear of goniometer housing, if coil was replaced.

(2) Insert new goniometer stator in same position as original stator through front of goniometer housing and partially screw the mounting screws (27) (removed in *c*(13) above), into stator. Stator screwhole locations prevent misorientation of stator in goinometer housing.

(3) Insert teflon shaft of spacing tool SCA–T2908 into front opening of goniometer stator where rotor would normally be inserted. Press in firmly until outside diameter of metal plate on tool fits flush against recessed lip of goniometer mounting face (24). (This face is identified by the three screwholes used for attaching rotor shaft retaining plate to front of goniometer housing.)

NOTE

Setscrews are sealed in position with glyptol or equivalent cement. Use solvent to soften this cement before use of Allen wrench. Damage to setscrew may result if cement is not removed.

(4) Adjust setscrews (25, fig. 6–2), one outside bottom center and two recessed inside of goniometer housing on brackets 1 3/4 inches to the rear of mounting slots. Gradually adjust each setscrew, in turn, until clearance between the outside diameter of the metal face of the spacing tool is exactly 0.004 inch from recessed diameter of goniometer mounting face (24).

(5) When clearance around the outside diameter of the tool mounting plate is 0.004 inch, the goniometer stator is properly centered. Use drop of glyptol or equivalent cement to secure setscrew adjustment.

(6) Screw the three rear screws (27) tight. Recheck for 0.004-inch clearance.

(7) Remove spacing tool.

(8) Solder black ground leads from stator to ground posts and remount ground posts inside goniometer housing.

(9) Replace top cover plate (32) on goniometer housing.

(10) Resolder leads to J1, J2, J3, J4, and J5.

(11) Replace sideplates on goniometer housing.

(12) Replace bearing (11, fig. 6–1) in goniometer shaft retaining plate (9) and goniometer rotor shaft (12) in bearing.

CAUTION

Be careful in next step as rotor will bind if spring washer (5) is replaced in reverse.

(13) Stand goniometer on end with mounting slots (3) facing up.

(14) Place a long pencil in goniometer extending from the bottom end of the T1 stator up through the goniometer face.

(15) Place spring washer (5) on a long pencil, with four spring points facing up.

(16) Allow washer to drop into center rear of T1 stator with points facing upward.

(17) Observe that washer is seated against bottom of goniometer housing, inside T1 stator, with spring points facing upward. Carefully withdraw pencil without disturbing washer position.

(18) With spring washer properly in place, insert goniometer rotor assembly (8).

(19) Goniometer rotor shaft bearing (6) will rest against points of spring washer (5).

(20) Rotate rotor shaft and check to see that rotor does not bind. If it does, repeat the instructions in (4) through (19) above.

(21) Replace three screws attaching goniometer shaft retaining plate to housing face.

e. Disassembly and Repair of Magnetic Sync Pulse Generator Assembly (fig. 6–1).

NOTE

The magnetic sync pulse generators on the TG–126/TRD and TG–126A/TRD are not interchangeable.

(1) Loosen two Allen head setscrews (19) on timing belt pulley (20) in the secondary goniometer drive housing (22).

(2) Loosen four mounting clamps (24) on rear mount of secondary goniometer drive housing (22).

(3) Remove sync assembly housing (27) from rear of secondary goniometer drive housing (22).

(4) Remove six screws (28) from backplate (34) of sync assembly. Remove plate. Resistor R1, capacitor C1, and diodes CR1 and CR2 are located inside the housing.

(5) Remove shaft retaining ring (29) holding shaft (31) in sync assembly housing (27).

(6) Remove bearing spacer (30) from shaft (31). Pull rotor (33) free.

(7) Remove and replace sync magnet (32) on rotor if defective (determine by substitution).

(8) To remove L1, remove sync stator housing (26), by loosening Allen head setscrew holding stator coil housing, unsoldering leads, and pushing coil sync assembly housing (27). Remove screws holding coil in housing and replace coil.

f. Reassembly of Sync Assembly (fig. 6–1).

(1) Replace stator coil housing (26) in sync assembly housing (27) until it touches the sync assembly rotor (33), then back housing off rotor 0.025 inch maximum. (Coil should be no further than 0.025 inch from sync rotor.) Resolder leads to coil.

(2) Replace spacer bearing (30) on sync assembly shaft (31).

(3) Replace sync assembly shaft (31) in sync assembly housing (27) and replace retaining ring (29).

(4) Replace sync assembly in drive housing (22).

(5) If secondary goniometer was removed before removing sync assembly, replace timing belt on pulley (20). To adjust timing belt, refer to paragraph 3–10*d*.

NOTE

It is not necessary to remove secondary goniometer to disassembly sync assembly. If secondary goniometer is not removed, belt will stay on pulley which will be held in position from rear by secondary goniometer flexible coupler (13).

(6) Replace timing belt pulley (20) inside secondary goniometer drive housing (22) on sync assembly shaft (31), space timing belt pulley (20) on sync assembly shaft (31) 1/4 inch from inside rear wall of secondary goniometer drive housing (22).

(7) Tighten two Allen head setscrews (15) in timing belt pulley (20) until pulley fits firmly on sync assembly shaft (31) in secondary goniometer drive housing (22). (Use access holes.)

g. Removal of Components from Drive Mounting Plate.

CAUTION

This disassembly is necessary only for repair or replacement of the rotary coupler housing or rotor, the drive motor, and the primary and secondary drive assemblies.

(1) Remove motor power connector plug (11, fig. 6–2) from chassis connector J2.

(2) Remove goniometers in accordance with instructions in *a* above.

(3) Remove 4 bolts from top and 16 nuts from bottom of drive, goniometer-rotary coupler chassis attaching shock-mounting plate (17, fig. 6–1) to chassis and remove from chassis.

(4) Remove two bolts holding angle bracket to shock-mounting plate (17).

(5) Use screwdriver to pry drive mounting plate (18) from shock mounting plate (17). Be careful so rubber shock absorbers (16) on shock mounting plate are not damaged.

NOTE

Considerable pressure is necessary to separate the mounting plate from shock mounts. To replace mounting plate, C-clamps must be used on all four corners to obtain enough pressure to firmly seat plate in rubber shock mounts.

(6) Remove six bolts from botton of drive mounting plate (18) holding primary drive housing, motor, and rotary coupler housing.

(7) Loosen Allen head setscrews holding flexible coupler (20, fig. 6–2) and timing belt pulley (18) on the motor shaft (14) in primary goniometer drive housing (16). Note that pulley clearance from rear drive housing wall is 1/4 inch.

(8) Remove timing belt (19) from pulley (18).

(9) Remove belt, pulley, and flexible coupler from inside primary goniometer drive housing (16) through access hole.

(10) Remove four motor mounting bolts (13) on inside primary goniometer drive housing motor mounting surface attaching motor to primary drive housing (16).

(11) Remove primary goniometer drive housing (16).

(12) Remove five motor mounting bolts (7) from synchronous motor (12) attaching it to rotary coupler housing (6) and remove motor.

(13) Remove Allen head setscrew in locknut (8) holding rotary coupler rotor shaft (4) in place in rotary coupler housing (6).

(14) Remove locknut (8).

(15) Remove rotary coupler rotor assembly (3).

h. Reassembly. To reassemble, reverse the order of disassembly, making certain that the face of timing belt pulley, (18) has 1/4 inch clearance from drive housing walls, and that goniometer flexible couplers are snug against goniometer rotor bearing in goniometer shaft retaining plate.

i. Removal and Replacement of E1, Rotary Coupler Stator (fig. 6–2).

(1) Remove five stator mounting screws (5) from rear of rotary coupler stator (1).

(2) Remove rotary coupler stator (1) from rotary coupler housing.

(3) Remove two shim spacing plates (2).

NOTE

This coil assembly is molded with potting compound, and is not repairable if defective.

4–18. Control Amplifier

a. To remove a part in the transistorized control amplifier, use a pencil-type soldering iron with a 25-watt maximum capacity.

b. Isolate an ac operated soldering iron from the line by a suitable isolation transformer to prevent current leakage from damaging the part.

c. Do not use a soldering gun. Damaging voltages can be induced in components.

d. The use of heat sinks on the leads of transistors, diodes, and tantalytic capacitors is necessary to prevent component damage from soldering heat. Long-nosed pliers will serve as an efficient heat sink when the component lead is firmly grasped.

4–19. Azimuth Indicator

a. Special handling of the crt is required when removal and replacement is necessary. Follow the procedures in *b*(2) and (3) below carefully to avoid serious personal injury.

WARNING

This is a critical operation and must be done exactly as described. Crt glass envelope is under negative pressure and could implode if cracked.

b. Remove the crt as follows:

(1) Remove three screws and hairline rotor knob from side of rim of alidade assembly and remove rim.

(2) DO NOT touch four spring-loaded, slotted head screws extending out from alidade assembly face.

(3) Insert 9/64-inch Allen head screwdriver in each of four recessed screws in face of alidade assembly and loosen each a little at a time until assembly comes off.

(4) Loosen clamp screws on neck of tube and socket clamp at rear of crt.

(5) Pull socket from crt base carefully.

(6) Push crt forward from rear. Heavy pressure must be exerted to push far enough out from rubber padding in steel housing to be able to grasp the front of the crt.

(7) When tube is far enough out in front to grasp, pull out carefully the rest of the way. Be careful the tube does not flip out suddenly.

c. Replace the crt as follows:

(1) Guide replacement tube carefully into housing so number 5 socket pin is top dead center. Connect socket.

(2) Place alidade assembly over front of tube and hold tightly against chassis in normal position.

(3) With other hand, rotate crosshair to make sure there is no binding or contact of alidade window with tube face.

(4) Be sure tube is not recessed too far. If so, move forward to proper position, and retest for binding or chafing.

(5) With crt in proper position, tighten the four Allen head screws, adjusting each a few turns at a time, going from one to the next in clockwise order.

(6) Replace three rim screws and crosshair rotor knob on alidade rim.

(7) Retest crosshair window rotation to make sure it is not binding at this point. If it is, loosen alidade assembly and push crt into housing 1/16 inch. Replace housing and retest window; it should not bind.

(8) Tighten tube clamp and connector clamp screws until tube and connector are firmly

seated. (Be certain that tube socket pin 5 is top dead center before tightening.)

4–20. Monitor Oscilloscope 120B

a. Replacement of Semiconductors.

(1) Excessive heat can destroy semiconductors. When soldering or unsoldering transistors or diodes, place a heat sink (such as long-nosed pliers) on the lead part.

(2) Isolate the oscilloscope from ground, or ground the body of the soldering iron to prevent leakage current from damaging the part.

(3) When replacing Q301, use a thin coat of silicone grease on each side of the insulator to improve heat transfer from transistor to deck.

b. Servicing Etched Circuit Boards.

(1) Removal of components, such as tube sockets, that are attached to the board at more than two points is difficult when trying to remove the part intact. First cut the pins or other connections between the body of the part and the circuit board, and then remove the pins individually.

(2) Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low-power soldering iron (50 watts maximum) and following these instructions. Cement copper that lifts off the board in place with a quick drying acetate base cement having good electrical insulating properties.

(3) Repair a break in the copper by soldering a short length of tinned copper wire across the break.

(4) Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

(5) When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, lift each pin slightly, working around the components several times until it is free.

c. Crt Replacement.

WARNING

When replacing the crt, handle it carefully; wear gloves and plastic face mask or goggles.

(1) Remove four mounting screws from bezel, and remove bezel.

(2) Loosen clamp screw on crt base; do not remove screw or clamp.

(3) Remove socket from crt base.

(4) Slide crt forward and out.

(5) Replace in reverse order.

(6) Energize the oscilloscope and obtain a free running trace.

(7) If necessary, align graticule and trace by adjusting SCALE control.

4–21. Target Transmitter

Most of the parts in the T–279A/UR are readily accessible and are easily replaced if found to be faulty.

a. If BANDSWITCH S603 requires replacement, mark the wires connected to the switch carefully with tags or other identification to avoid misconnection when a new switch is installed.

b. To replace any one of the 12 rf coils, first unsolder the leads from the top of the coil. Then unscrew the nut holding the coil to the vertical chassis, and lift out the coil.

c. Be sure to mark leads which must be disconnected to permit replacement of items having multiple connections as instructed in *a* above.

Section IV. ADJUSTMENT AND ALIGNMENT

4–22. General

a. The adjustment and alignment procedures in this section should be performed after repair of a unit and before re-issue for use.

b. When depot maintenance is performed, the repaired unit must pass final testing procedures before release.

c. Refer to the test equipment listed in paragraph 4–3 for test equipment required.

4–23. Antenna Coupler Alignment

After replacement of a defective component, the gain response and intermodulation distortion should be checked. The replacement of most components does not require readjustment; however, replacement of transistor will probably require rebalancing the circuitry.

a. Test Equipment Required. Refer to paragraph 4–3 for test equipment required.

b. Gain Response. Perform the procedures in paragraph 4–5*d*. If the gain response is not normal, repair is indicated.

c. Intermodulation Distortion Adjustment.

(1) Place the TEST METER switch in the position which corresponds to the transistor which was replaced. The front panel meter should indicate 50.

(2) If a transistor on A1 is being monitored, adjust potentiometers A1R7 and A1R6 and capacitors A1C12 and A1C11 to obtain a

front panel meter indication of 50. If a transistor on A2 is being monitored, adjust potentiometers A2R3 and A2R4 to obtain a meter indication of 50. See figure 4–45 for the location of these adjustments.

4–24. Goniometer Drive Alignment

Replacement of the primary or secondary goniometers, rotary coupler, or sync pulse generator requires realignment of the goniometer drive.

a. Test Equipment Required. Refer to paragraph 4–3 for common names.

Federal stock No.	*Equipment*	*References*
6625–868–8353	Generator, Signal AN/GRM–50	TM 11–6625–573–15
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
5825–918–6991	Amplifier, Electronic Control AM–3345/TRD	TM 11–5825–231–25

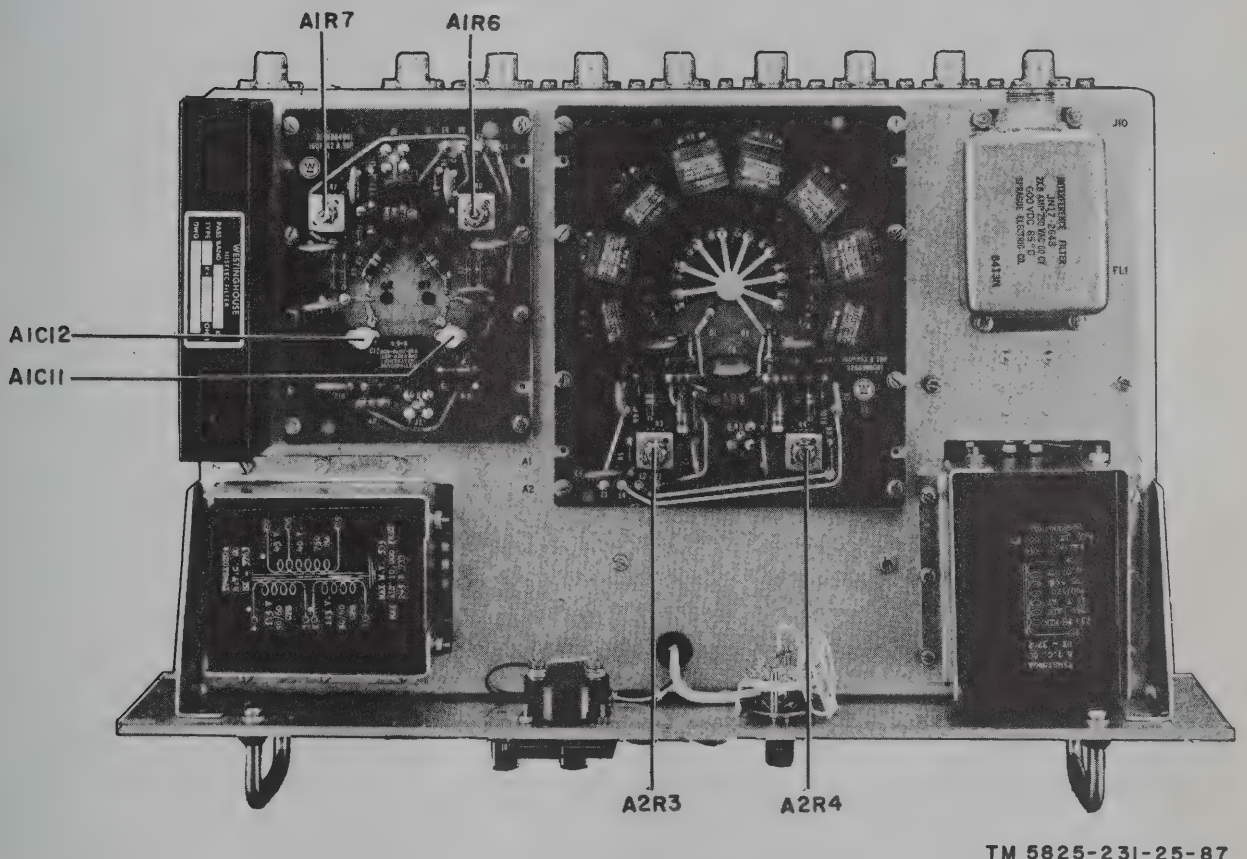


Figure 4–45. Antenna coupler, location of adjustments.

b. Alignment of Sync Pulse Generator. This procedure is used to align the sync pulse generator with the rotary coupler, and must be performed when either of these units has been removed or replaced.

(1) Connect the goniometer drive as shown in figure 4–46. Adjust the rf generator for 2 MHz, 1 volt output.

(2) Turn on the control amplifier and adjust the oscilloscope controls to display the output of the rotary coupler (a bell-shaped curve) and the sync pulse.

(3) The sync pulse should occur at the peak of the bell-shaped curve. If not, proceed to (4) below.

(4) Turn off the control amplifier. Lock the drive shaft, using the thumbscrew at the rear of the sync pulse generator.

(5) Loosen the setscrews on the drive belt pulley on the secondary goniometer shaft. Ro-

tate the pulley (moving the drive belt and rotating the rotary coupler) the desired number of degrees.

NOTE

The bell-shaped curve width is equal to approximately 15° rotation.

(6) Tighten the drive pulley setscrews. Release the drive shaft using the thumbscrew at the rear of the sync pulse generator.

(7) Repeat (2) through (5) above until the sync pulse and the rotary coupler have the proper relationship.

c. Secondary Goniometer Alignment (fig. 4–47). This procedure is used to align the sync pulse generator with the secondary goniometer, and must be performed when either of these units has been removed or replaced.

(1) Connect the goniometer drive as shown in figure 4–46. Adjust the signal generator for a 72-kHz, 1-volt output.

(2) Turn on the control amplifier and adjust the oscilloscope controls to display two sync pulses. Adjust the A CHAN input for a suitable display of the 72-kHz envelope.

(3) Loosen the two thumbscrews on the secondary goniometer housing and rotate the goniometer to bring the maximum amplitude of the 72-kHz signal and the negative peak of the sync pulse signal into coincidence. Tighten the thumbscrews. (See figure 6–1 for the location of the mechanical parts.)

(4) Shut off the control amplifier.

(5) Lock the shaft of the sync pulse generator using the thumbscrew at the rear of the unit.

(6) Loosen the front setscrews in the flexible coupler, and rotate the coupler and goniometer shaft the same number of degrees *opposite* to the rotation accomplished in (3) above. Tighten the flexible coupler setscrews, and reset the reference indicator on the goniometer to zero.

(7) Release the shaft of the sync pulse generator and turn on the control amplifier.

(8) Repeat (2) through (6) above until coincidence between the sync pulse and the peak of the 72-kHz envelope occurs. This coincidence occurs when the secondary goniometer reference indicator is set at zero.

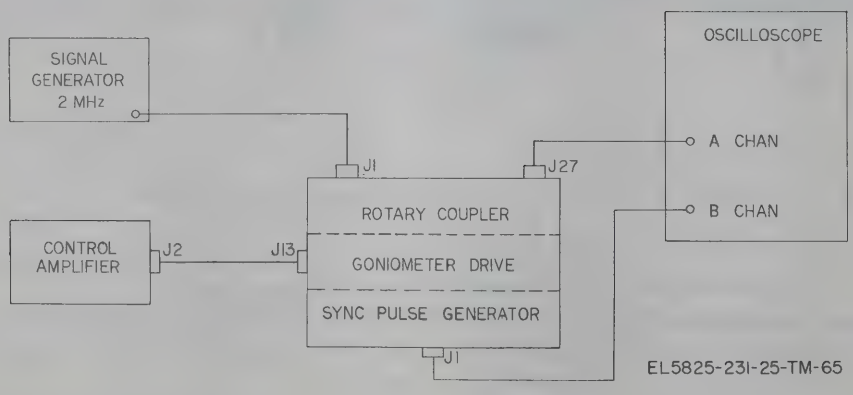


Figure 4–46. Sync pulse generator, alignment test setup.

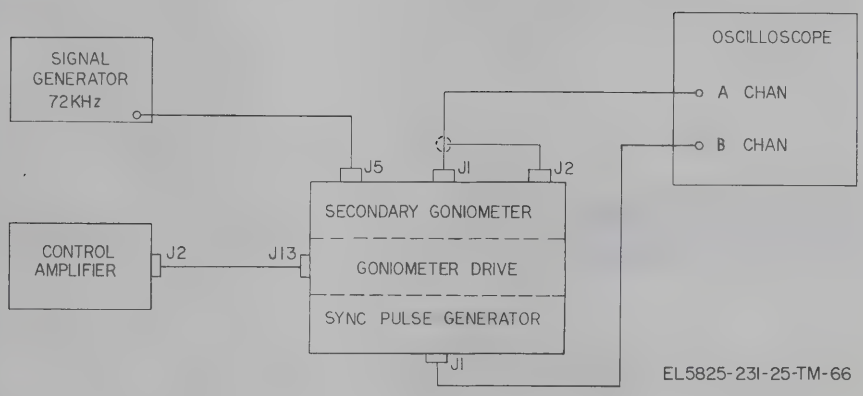


Figure 4–47. Secondary goniometer, alignment test setup.

d. Primary Goniometer Alignment. This procedure is used to align the primary goniometer with the sync pulse generator, and must be performed if the primary goniometer has been removed or replaced.

(1) Connect the goniometer drive as shown in figure 4–48. Adjust the signal generator for a 72-kHz, 1.0-volt output.

(2) Turn on the control amplifier, and adjust the A CHAN input for a suitable display of the 72-kHz signal.

(3) Loosen the two thumbscrews on the primary drive housing and rotate the primary goniometer to synchronize the maximum amplitude of the 72-kHz signal and the negative peak of the sync pulse signal. See figure 6–2 for the location of the mechanical parts.

(4) Shut off the control amplifier and lock the drive shaft using the thumbscrew at the rear of the sync pulse generator.

(5) Loosen the two setscrews on the rear of the flexible coupler, and rotate the coupler and primary goniometer rotor shaft the same number of degrees *opposite* to the rotation in (3) above. Tighten the flexible coupler setscrews and reset the reference indicator to zero. Tighten the thumbscrews.

(6) Release the drive shaft by loosening the thumbscrew on the rear of the sync pulse generator, turn on the control amplifier, and repeat (1) through (5) above until the 72-kHz signal and the sync pulse are in coincidence when the reference indicator is zero.

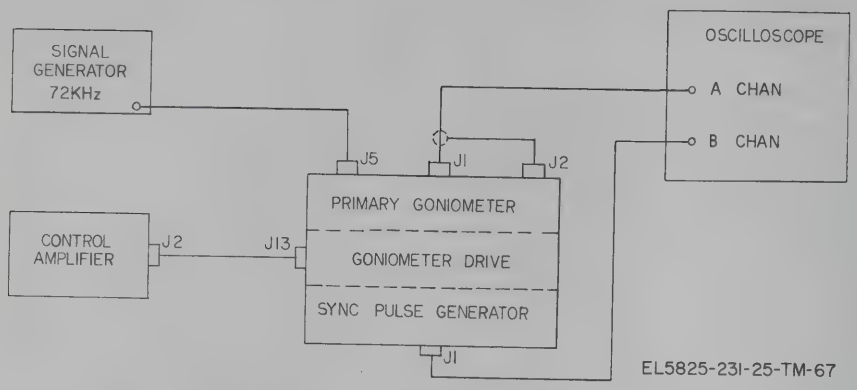


Figure 4–48. Primary goniometer, alignment test setup.

4–25. Control Amplifier Adjustments

Replacement of a component in the control amplifier will require adjustment of POWER OUTPUT control R25.

a. Test Equipment Required.

Federal stock No.	*Equipment*	*References*
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–6625–320–12
5950–235–2086	Transformer, Variable, Power CN–16/U	
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
5950–914–6807	Drive, Goniometer, Rotary Coupler TG–126(*)/TRD	TM 11–5825–231–25

b. Output Adjustment.

(1) Connect the control amplifier as shown in figure 4–9.

(2) Turn on the control amplifier and adjust the line voltage to 115 volts with the variac.

(3) Disconnect the multimeter from the input and connect it to pins A and B of J2.

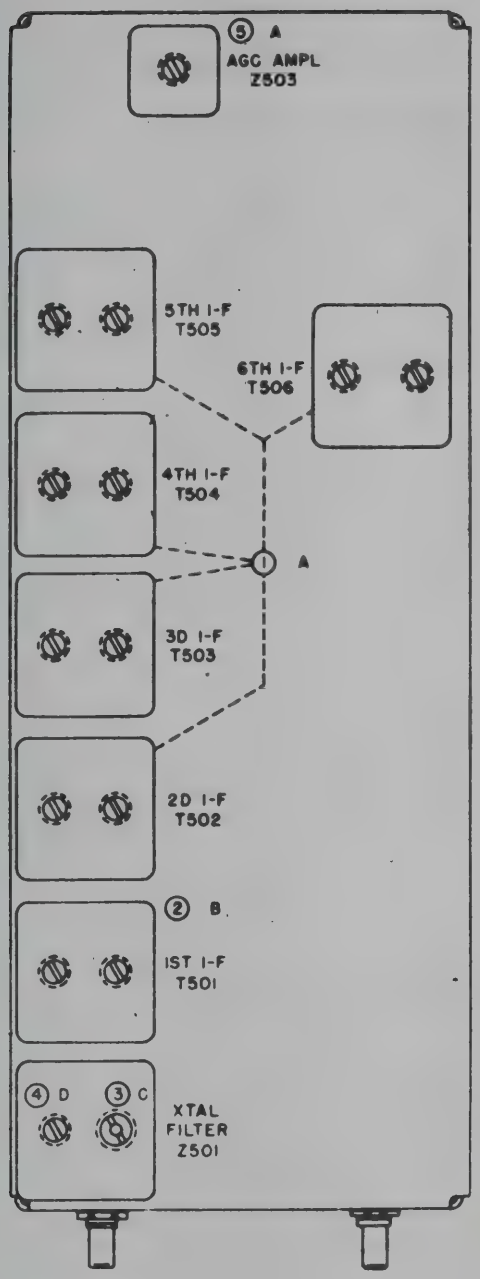
(4) Adjust R25 for 115 volts on the multimeter.

4–26. Receiver Alignment

Alignment instructions for the R–725/URR receiver are available in TM 11–5820–358–35. The following section covers overall gain and bandwidth alignment procedures for the if. subchassis. See figure 4–49 for location of alignment points and figures 4–50 and 4–51 for appropriate test setups called for below.

a. Test Equipment Required.

Federal stock No.	*Equipment*	*References*
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
6625–913–9781	Multimeter ME–26B/U	TM 11–6625–200–15
6625–868–8353	Generator, Signal AN/GRM–50	TM 11–6625–573–15
5950–235–2086	Transformer, Variable, Power CN–16/U	



LEGEND:

ADJUSTMENT FOR ALINEMENT.
A. BANDWIDTH SWITCH 2-KC POSITION.
B. BANDWIDTH SWITCH 8-KC POSITION.
C. BANDWIDTH SWITCH .1-KC POSITION.
D. BANDWIDTH SWITCH 1-KC POSITION.

NOTES:

1. CIRCLED NUMBERS INDICATE SEQUENCE OF ALINEMENT.
2. SIGNAL GENERATOR TUNED TO 455KC. RECEIVER MAY BE TUNED TO ANY FREQUENCY.

EL5825-231-25-TM-68

Figure 4–49. If. subchassis, alignment chart.

b. Alignment Test Setup and Control Settings.

(1) Connect Radio Receiver R-725/URR as shown in figure 4–50. Use the variac to maintain the supply at 115 volts ac.

(2) Before performing the alignments, allow the receiver to warm up for 1 hour minimum.

(3) Connect the signal generator to test point E211 (control grid of third mixer tube V204).

(4) For an output meter, connect the

grounded lead of the dc vtvm to the receiver chassis, and connect the other lead to DIODE LOAD terminal 14 of the rear terminal strip. Set the function switch of the dc vtvm for measuring negative dc voltage.

(5) Set the receiver BANDWIDTH KC switch to .1, RF GAIN control to 10, BFO switch to OFF, and FUNCTION switch to MGC.

c. Alignment Procedure. Tune the rf generator to 455 kHz (unmodulated); then adjust its frequency control for peak reading on the dc vtvm. To obtain a peak reading, it may be necessary to set the attenuation of the signal generator for high amplitude output signal (3 volts). If no reading on the dc vtvm is obtained, perform the procedure in *d* below.

d. Approximate Alignment.

(1) Tune the rf generator to 455 kHz and set the attenuator for full output. Turn the receiver BANDWIDTH switch to 16 kHz. If the output reading is not yet obtained, proceed with (2) below. If it is obtained, adjust the cores of transformers T506 through T501 and T207, in that order, for peak reading on the dc vtvm. Then, set the receiver BANDWIDTH KC switch at the next lower position, and repeat the adjustment of the transformer cores for peak output. Repeat this procedure for each setting of the BANDWIDTH KC switch until peak output is obtained at .1 position of the switch; then proceed to *e* below.

NOTE

The frequency will decrease as the slugs are screwed further into the coils, and will increase as the slugs are withdrawn.

(2) Perform the procedures outlined below only when the transformer cores have been displaced greatly from their normal positions within the coils. Set the receiver BANDWIDTH KC switch to 2 and proceed as follows:

(*a*) Tune the rf generator to 455 kHz and set the attenuator for maximum output. Remove sixth if. amplifier tube V506, and wrap a thin wire lead around pin 1 (grid). Replace the tube, and connect the other end of the lead to the rf generator output.

(*b*) Adjust the cores of transformer T506 for peak reading on the dc vtvm.

(*c*) Apply the dc generator output to fifth if. amplifier V505 the same way as for V506 (*a* above), and adjust the cores of transformer T505 for maximum indication on the dc vtvm.

(*d*) Repeat the above procedure for each remaining set of if. tubes and transformers in the following order: V504 and T504, V503 and T503, V502 and T502, V501 and T501, and V204 and T208.

(*e*) Set the receiver BANDWIDTH KC switch to .1 and proceed as outlined in *e* below.

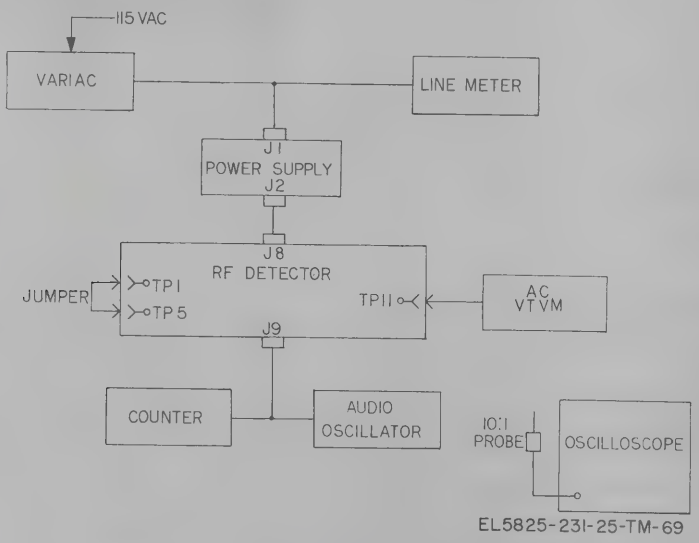


Figure 4-50. Radio Receiver R-725/URR, test setup, alignment.

e. If. Alignment.

NOTE

Resistors R519, R520, R521, and R561 have the following nominal values: R519—1 K ohm; R520—3.3 K ohm; R521—3.9 K ohm; and R561—2.7 K ohm. These resistors directly affect bandwidth and gain, and their values may have to be changed later in the test procedure (*i* below).

(1) Connect the rf generator output to the test point and set the rf generator frequency at

455 kHz. Carefully tune the rf generator to the exact frequency required to obtain peak output reading on the dc vtvm. While adjusting the rf generator attenuator to maintain an output of approximately 6 volts (as read on the dc vtvm). Do not disturb this frequency setting while performing the instructions in (2), (3), and (4) below. Check the setting repeatedly to make sure it has not changed.

(2) Set the receiver BANDWIDTH KC switch to 2.

(3) Adjust the cores of transformers T506, T505, T504, T503, T502, and T208, in that order, for peak output reading, while continuously adjusting the attenuator of the signal generator to maintain a reading of approximately 6 volts on the dc vtvm. Repeat these adjustments until no further increase in output is noticeable.

(4) Change the setting of the receiver BANDWIDTH KC switch to 8, and adjust the cores of transformer T501 for maximum output. Repeat the adjustment of cores until no further increase in output can be produced.

(5) Return the receiver BANDWIDTH KC switch to .1.

f. Phasing Capacitor Adjustment.

(1) Set the rf generator attenuator for a reading of approximately 6 volts on the dc vtvm and note the attenuator setting. Increase the output 60 db above this setting and decrease the generator frequency until 6 volts is again obtained on the dc vtvm.

(2) Adjust the phasing capacitor in crystal filter Z501 for a minimum dc vtvm reading, and note the position of the capacitor slot.

(3) Tune the signal generator to the high side of the center frequency as required to obtain 6 volts on the dc vtvm.

(4) Adjust the phasing capacitor for minimum reading, and note the position; then set the capacitor approximately halfway between the two settings. To avoid incorrect readings, caused by tuning through the positions of minimum or maximum capacitance, the two settings for minimum or maximum capacitance, the two settings for minimum output must be less than 45° apart.

g. Crystal Filter Adjustment.

(1) With the receiver BANDWIDTH KC switch at .1, tune the rf generator to obtain peak output.

(2) Set the BANDWIDTH KC switch to 1. Adjust the core of the tuning coil in crystal filter Z501 until the frequency reading required for obtaining peak output corresponds exactly with the frequency reading required for peak output with the receiver BANDWIDTH KC switch at .1. Retune the rf generator, and alternately change positions of the BANDWIDTH KC switch as required to complete this adjustment.

h. Agc Adjustment.

(1) Set the receiver BANDWIDTH KC switch to .1, and tune the rf generator for maximum output as described in *e* above. Do not disturb this frequency setting during the adjustment of the agc tuning circuit in the steps in (2), (3), and (4) below.

(2) Disconnect the dc vtvm lead from terminal 14 of the rear terminal strip, and connect it to terminal 4 of the rear terminal strip.

(3) Set the receiver FUNCTION switch to AGC and the BANDWIDTH KC switch to 2.

(4) Adjust the core of Z503 for a maximum voltage reading on the dc vtvm while adjusting the rf generator attenuator to maintain a peak reading of approximately 2 volts. When the adjustment is completed, reconnect the meter to terminal 14 (diode load).

i. Resistor Selection (fig. 4–50).

(1) Switch the receiver BANDWIDTH KC switch to .1, 1, 2, 4, 8, and 16 and observe the output reading on the dc vtvm. If the output changes by more than 10 db, the corresponding resistor must be reselected to maintain the overall gain of the if.

(2) The resistors affecting the corresponding bandwidths are as follows:

R519:	8 kHz
R520:	4 kHz
R521:	0.1 kHz, 1 kHz, 2 kHz
R561:	0.1 kHz

j. Overall Gain Adjustment.

(1) Connect equipment as shown in figure 4–51 and set the controls as follows:

Control	*Setting*
Rf generator:	
Frequency	4.0 MHz
Output level	1.0 to 4.0 uV
Mode	CW
Receiver:	
FUNCTION	MGC
BANDWIDTH KC	8
RF GAIN	Maximum cw

(2) Tune the receiver ANT TRIM control for maximum as read on the dc vtvm. This reading shall be 7 volts minimum.

(3) If the above reading of 7 volts is not obtained, adjust R62.

k. If. Selectivity.

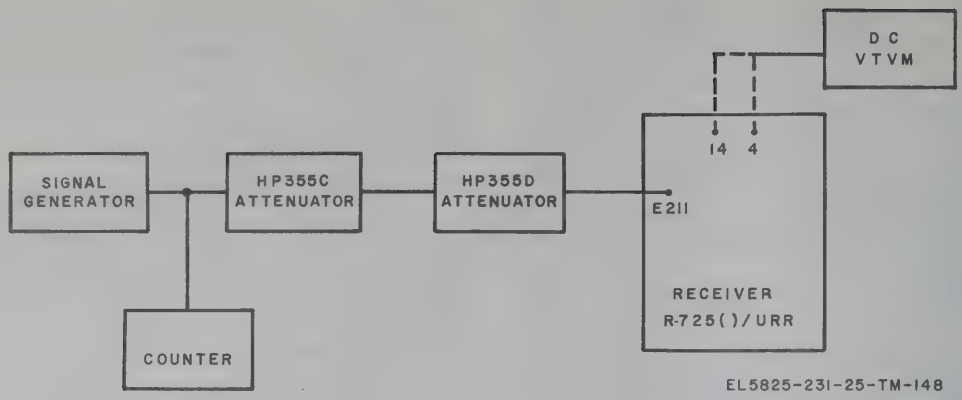


Figure 4–51. Radio Receiver R–725/URR, gain test setup.

(1) Using the test setup in figure 4–51, set controls as follows:

Control	*Setting*
Rf Generator:	
Output level	0.3 V
Frequency	550 kHz
Attenuators	70 db minimum
Receiver:	
FUNCTION	MGC
BANDWIDTH KC	.1 position
RF GAIN	Maximum
Dc vtvm	.1 V position-connected to J116

(2) Tune the receiver for a maximum output as read on the dc vtvm.

(3) With the dc vtvm in the 0.2-volt range (−20 dbm), insert additional attenuation and reduce the receiver RF GAIN control to obtain 0 db on the voltmeter scale. Check the output for overload by observing that 1 db attenuation of input level results in 1 db decrease in output level as indicated by the dc vtvm.

NOTE

If an overload is observed, the receiver RF GAIN must be decreased until the overload condition is removed as determined by (3) above.

(4) Tune rf generator to the low side of center frequency until the output on the dc vtvm decreases by 6.0 db and note this frequency. Repeat this procedure on the high side of center frequency and note the results.

(5) The difference between the two frequencies noted in (4) above shall be between 0.1 kHz and 0.18 kHz. If not, R561 must be reselected.

(6) Remove 60 db of attenuation and tune the generator to the low side of center frequency until the output read on the dc vtvm indicates 0 db. Note this frequency. Repeat this procedure on the high side of center frequency and note the result.

(7) The difference between the two frequencies noted in (6) above shall be a maximum of 5.4 kHz. If not, R561 must be reselected.

(8) Repeat the steps in (4) and (6) above for the 1 position. The limit for the 6-db bandwidth is 0.9 kHz minimum to 1.5 kHz maximum and the 60-db measurement shall be a maximum of 7.2 kHz. If the bandwidths do not meet those specifications, adjust the core of T501.

(9) Repeat the steps in (4) and (6) above for the 2.0 kHz position. The limit for the 6-db bandwidth is 1.7 kHz minimum to 2.5 kHz maximum and the 60-db measurement shall be a maximum of 9.5 kHz. If the bandwidths do not meet these specifications, R521 must be reselected.

(10) Tune the rf generator to 4.4 MHz, and with the receiver BANDWIDTH KC switch at 4, tune the receiver for maximum output, using the dc vtvm as a tuning indicator.

(11) Repeat the steps of (4) and (6) above for the 4.0 kHz position. The limit for the 6-db bandwidth is 3.2 kHz to 4.6 kHz and the 60-db measurement shall be a maximum of 11.0 kHz. If the bandwidths do not meet these specifications, R520 must be reselected.

(12) Repeat the steps of (4) and (6) above for the 8 position. The limit for the 6-db bandwidth is a maximum of 11.5 kHz and the 60-db measurement shall be a maximum of 22.0 kHz.

(13) Repeat the above procedure for the 3-db points with the limit of a minimum of 6.6 kHz frequency difference.

NOTE

If the bandwidths for the 8 position are not within specification, R519 must be reselected or T501 stagger-tuned. In the case of stagger tuning, refer to the procedure in (14) through (20) below.

(14) Refer to figure 4–51, and set the controls as follows:

Rf generator	*Setting*
Frequency	4.4 MHz
Output	0.3 V (0 dbm or higher)
Attenuator	70 db minimum
Receiver	
FUNCTION	MGC
BFO	OFF
BANDWIDTH KC	8
RF GAIN	
Dc vtvm	Connected to J116

(15) Tune the receiver to maximum output as indicated on the dc vtvm, and with the meter in the 0.1-volt range (−20 dbm), insert additional attenuation and reduce RF GAIN control to obtain 0 db reference on the dc vtvm.

(16) Check output for overload as in (3) above.

(17) Tune the rf generator to the low side of center frequency until the dc vtvm reading decrease 3.0 db and note this frequency. Repeat this procedure for the high side of center frequency. The difference between the two frequencies is the 3-db bandwidth.

(18) If the bandwidth is too narrow (the limit is 6.6 kHz minimum), stagger tuning is accomplished by slightly tuning T501 to meet the bandwidth and peak-to-valley requirements.

(19) Turn the receiver BANDWIDTH KC switch to the 16 and check bandwidth as before. The limit for the 3-db points is a minimum of 10.0 kHz; the limits for the 6-db points is a maximum of 17.0 kHz; and the limit for the 60-db points is a maximum of 31.0 kHz.

(20) Check the peak-to-valley ratio by slowly tuning the signal generator through the 6-db bandpass and looking for maximum and minimum indications on the dc vtvm. The peak-to-valley difference will be 4 db maximum.

l. If. Output Characteristics.

(1) Refer to figure 4–51, and set the equipment as follows:

Rf generator	*Setting*
Frequency	1.55 MHz
Function	CW
Output	3 microvolts
Receiver	
BANDWIDTH	8
BFO	OFF
FUNCTION	MGC
RF GAIN	Maximum

Attenuators set for 0 db
Dc vtvm connected to J116

(2) Tune receiver for maximum output as indicated by the dc vtvm, and turn receiver FUNCTION switch to AGC.

(3) There will be a minimum reading of 20 millivolts. If not, readjust R62.

(4) Switch receiver FUNCTION switch to MGC and adjust the rf GAIN control for a 20-millivolt reading on the dc vtvm.

(5) Set the rf generator output to 30 microvolts and observe that the dc vtvm now reads from 170 millivolts to 230 millivolts.

m. Am. Sensitivity.

(1) Connect the equipment as shown in figure 4–51 with the dc vtvm connected to TB102, pins 6 and 7.

(2) Set the receiver controls as follows:

FUNCTION	MGC
BANDWIDTH	8
BFO	OFF
KILOCYCLE CHANGE	16 MHz

(3) Set rf generator to 16 MHz at an output of 3.3 microvolts, 30 percent 400-Hz modulation.

(4) Adjust the receiver LOCAL GAIN control for a reading of 0 db on the dc vtvm, and then turn the rf generator modulation off and note the db difference as indicated on the meter. This will be a minimum of 10 db.

n. Bfo Operation.

(1) Using the same test setup as in *m* (1) above, turn the rf generator modulation off and turn the receiver BFO switch to ON.

(2) Rotate the receiver BFO PITCH control and observe that the dc vtvm reading varies as this is done.

4–27. Rf Detector Alignment

The alignment procedures for the rf detector should be performed for each section of the circuitry when a component in that circuit has been repaired or replaced.

a. Test Equipment Required. Refer to paragraph 4–3 for common names.

Federal stock No.	*Equipment*	*References*
6625–783–5965	Generator, Signal AN/URM–127	TM 11–6625–683–15
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
6625–911–6368	Counter, Electronic Digital Readout AN/USM–207	TM 11–6625–700–10
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–6625–320–12
5950–235–2086	Transformer, Variable, Power CN–16/U	
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15

b. Test Setup. Install the rf detector as shown in figure 4–52. Set the controls of the test equipment as follows:

Equipment	*Control*	*Setting*
Oscilloscope	SWEEP	1 mv/cm
Signal Generator AN/URM–127	SYNC	INT.
	FREQUENCY	90 Hz.
Rf detector	DF Gain	cw

c. Preliminary Adjustments.

(1) Turn on the rf detector and the power supply. Adjust the line voltage to 115 volts with the variac.

(2) With the TS–352B/U, measure the voltage at TP13 in the rf detector. Adjust power supply output control R13 for a +250-volt dc reading at TP13.

(3) Measure the hum voltage at TP11 in the rf detector with the ME–30B/U. Adjust power supply hum control R2 for a null voltage at TP11.

d. No. 2 Limiter Alignment.

(1) Connect the oscilloscope to TP2 and adjust L5 for maximum amplitude of the display.

(2) Remove crystal Y2 and connect the oscilloscope to TP3. Adjust L6 for maximum amplitude.

(3) Replace crystal Y2.

e. No. 1 Limiter Alignment.

(1) Connect the oscilloscope to TP6 and adjust L8 for maximum amplitude of the display.

(2) Remove crystal Y3 and connect the oscilloscope to TP7. Adjust L9 for maximum amplitude.

(3) Replace crystal Y3.

f. Mixer Alignment.

(1) Connect the oscilloscope to TP9.

(2) Adjust L7 and L10 for maximum amplitude of the 5-kHz signal displayed.

g. Harmonic Filter Alignment.

(1) Rotate DF LEVEL control R89 fully cw.

(2) Turn on the audio signal generator and adjust the output level for a reading of +10 dbm on the ME–30B/U.

(3) Tune the oscillator to exactly 360 Hz, as verified by the counter. Adjust L11 and R100 for a null on the ME–30B/U.

(4) Tune the oscillator to exactly 270 Hz, as verified by the counter. Adjust L12 and R102 for a null on the ME–30B/U.

(5) Tune the oscillator to exactly 180 Hz, as verified by the counter. Adjust L13 and R104 for a null on the ME–30B/U.

h. Auxiliary Balance.

(1) Connect the oscilloscope to TP12.

(2) Adjust the audio oscillator for exactly 90 Hz, as verified by the counter.

(3) Adjust AUX BALANCE control R113 for a balanced negative-going, full-wave rectified output.

4–28. Power Supply Adjustments

The procedure for adjustment of the power supply has been discussed in paragraph 4–27*c* during alignment of the rf detector. However, when the rf detector is not available as a normal load for the power supply, follow the procedures described in paragraph 4–10*d*.

4–29. Azimuth Indicator Alignment

Alignment of the azimuth indicator is required when components affecting the circuitry in the

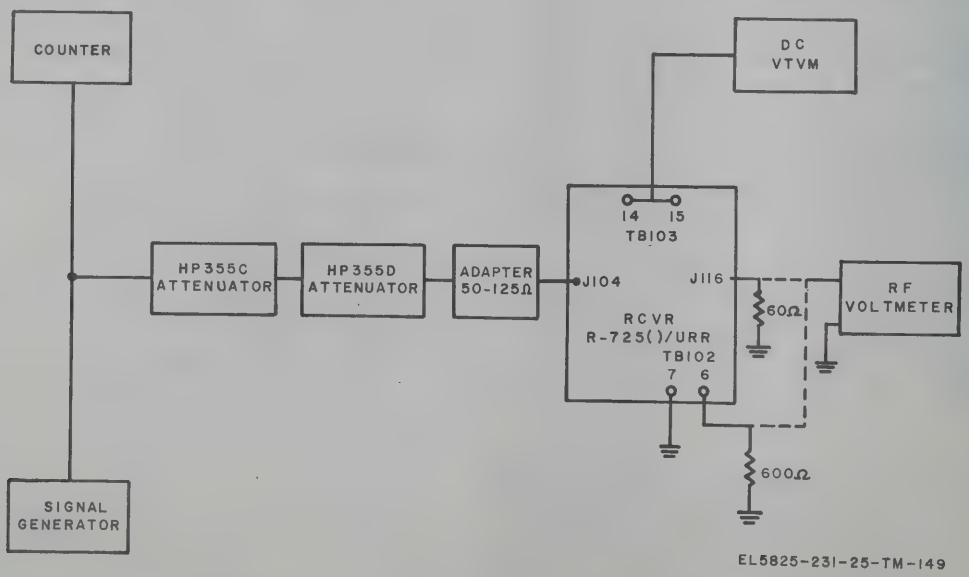


Figure 4–52. Rf detector, alignment test setup.

following procedures have been repaired or replaced.

a. Test Equipment Required. Refer to paragraph 4–3 for common names.

Federal stock No.	*Equipment*	*References*
6625–783–5965	Generator, Signa AN/URM–127	TM 11–6625–683–15
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–6625–320–12
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
5950–235–2086	Transformer, Variable, Power, CN–16/U	
6625–868–8353	Generator, Signal AN/GRM–50	TM 11–6625–573–15
5825–918–6991	Amplifier, Electronic Control AM–3345/TRD	TM 11–5825–231–25
5950–914–6807	Drive, Goniometer, Rotary Coupler TG–126(*)/U	TM 11–5825–231–25

b. Control Settings.

Equipment	*Control*	*Setting*
Signal Generator AN/URM–127	FREQUENCY	90 Hz
	OUTPUT	3 Volt
Signal Generator AN/URM–50	FREQUENCY	72 kHz
	OUTPUT	1 volt
Azimuth indicator	INDICATOR	OFF
	INTENSITY	Fully ccw
	FOCUS	Center of rotation
	HORIZONTAL	Center of rotation
	VERTICAL	Center of rotation
	DIMMER	Fully ccw
	DF GAIN	Fully ccw
	SIZE	Fully ccw
	SHAPE	Center of rotation

c. Low-Voltage Power Supply.

(1) Turn on the azimuth indicator and adjust the INTENSITY and FOCUS controls for a sharp, clear trace.

CAUTION

Too high a setting of the azimuth indicator INTENSITY control will damage the crt.

(2) Connect the TS–352B/U to the junction of R87 and C29. Adjust B+ control R72 for a +275-volt dc reading on the TS–352B/U.

(3) Disconnect the TS–352B/U. Connect the ME–30B/U to the junction of R87 and C29. Adjust HUM BALANCE control R67 for a null on the ME–30B/U.

d. Deflection Circuit Adjustments.

(1) Connect the audio signal generator to J5 and J6 of the azimuth indicator.

(2) Adjust the HORIZONTAL and VERTICAL centering controls to center the dot on the crt. Adjust the FOCUS and INTENSITY controls as required.

(3) Turn on Signal Generator AN/GRM–50 and adjust the output to obtain a vertical line on the crt face. Adjust T5 for maximum length of the line. Adjust Signal Generator AN/GRM–50 output so the vertical line exactly fills the crt face.

(4) Without disturbing the controls on Signal Generator AN/GRM–50, disconnect it from J5 and J6 and connect it to J3 and J4. Adjust T4 for maximum length of the horizontal line. Adjust azimuth indicator SHAPE control R17 so the horizontal line exactly fills the crt face.

(5) Disconnect the Signal Generator AN/GRM–50.

e. 72-kHz Oscillator Alignment.

(1) Connect the ME–30B/U to the junction of R88 and C16.

(2) Adjust L1 for peak signal on the ME–30B/U.

f. 72-kHz Sweep Alignment.

(1) Connect the azimuth indicator as shown in figure 4–29.

(2) Turn on the control amplifier and adjust azimuth indicator SIZE control R33 to obtain a three-quarter screen circular deflection. If the display is not circular, the SHAPE control may have to be readjusted.

(3) Adjust T2 for a maximum deflection on the crt.

(4) Adjust T3 for a maximum deflection on the crt.

(5) A slight readjustment of T4 and T5 may be required to minimize the center of the display.

g. Propeller Alignment.

(1) With the equipment connected as in *f* above, remove tube V7 to disable the blanking circuit.

(2) Increase D.F. GAIN control R1 to obtain a full propeller pattern.

(3) Adjust frequency of AN/URM–127 to achieve a slowly rotating propeller pattern. While observing rotating pattern, adjust BALANCE control R9 and CUSP BALANCE R77 to obtain an optimum superimposed propeller, with minimal side splits and angular splits throughout the 360° rotation. (R9 controls side splits while R77 controls angular tip splits.)

h. Blanking Adjustment.

(1) With the equipment connected as in *g* above, insert tube V7 into its socket.

(2) Adjust T7 so that one-half of the propeller is completely blanked out. Precise adjustment is required to eliminate any ghosts or tails.

4–30. Monitor Oscilloscope Alignment

Alignment instructions for the HP120B oscilloscope are presented below. To align the AN/USM–318(V)*1* oscilloscope, refer to the instructions in TM *11–6625–1703–15* and chapter 8.

a. Test Equipment Required. Refer to paragraph 4–3 for common names.

Federal stock No.	*Equipment*	*References*
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–6625–320–12
6625–783–5965	Generator, Signal AN/URM–127	TM 11–6625–683–15
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
6625–911–6368	Counter, Electronic Digital Readout AN/URM–207	TM 11–6625–700–10
5950–235–2086	Transformer, Power, Variable CN–16/U	
6625–913–9781	Multimeter ME–26B/U	TM 11–6625–200–15

b. Alignment Test Setup.

(1) Connect the monitor oscilloscope to the line through the variac, and adjust the voltage to 115.

(2) Refer to figures 4–38 through 4–41 for the location of controls and adjustable components.

c. Low-Voltage Power Supply.

(1) Turn on the monitor oscilloscope. Adjust the oscilloscope INTENSITY and FOCUS controls for a sharp, clear trace.

(2) Connect the ME–26B/U to pin 2 of V311.

(3) Adjust LOW VOLTAGE SET control R352 for −150 volts dc on the ME–26B/U.

d. High-Voltage Power Supply.

NOTE

Adjustment of the high voltage affects crt deflection sensitivity, intensity, focus, and astigmatism. Check horizontal and vertical gain adjustments following any adjustment of the high voltage. Intensity, focus, and astigmatism adjustments are included in the following adjustment of high-voltage power supply.

WARNING

Voltages in excess of 2,500 volts are present in the high-voltage power supply. Take all possible precautions when performing high-voltage measurements.

(1) Connect the multimeter hv probe between terminal 17 or 18 of transformer T302 and ground.

(2) Adjust potentiometer R308 for a multimeter reading of −2,500 volts.

(3) Switch oscilloscope HORIZONTAL DISPLAY to 1 VOLTS/CM and center the spot.

(4) Set INTENSITY control to 9 o'clock and adjust R320 to the point where the spot just extinguishes.

(5) Increase INTENSITY control and adjust FOCUS control for best spot.

(6) Adjust astigmatism control R316 for small round spot, readjusting FOCUS control as required.

e. Vertical Amplifier Balance.

(1) Set oscilloscope VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.

(2) Set VERTICAL AC-DC switch to DC.

(3) Short vertical input terminals.

(4) While rotating VERTICAL VERNIER back and forth, adjust BAL control for no shift of spot.

f. Vertical Gain Adjustment.

(1) Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.

(2) Set VERTICAL VERNIER to CAL.

(3) Using output of AN/URM–207, apply a 400-Hz 0.1-volt peak-to-peak signal to the VERTICAL input terminals.

(4) Adjust oscilloscope CAL screwdriver adjustment for a crt deflection of 10 cm.

g. Vertical Attenuator Adjustment.

(1) Connect output of AN/URM–207 to the vertical input terminals.

(2) Rotate VERTICAL VERNIER fully counterclockwise.

(3) Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.

(4) Set VERTICAL AC-DC switch to AC.

(5) Set HORIZONTAL DISPLAY to 5 msec/cm.

(6) Adjust AN/USM–207 for pulse repetition rate of 1 kHz and set amplitude for 10 cm crt deflection.

(7) Adjust capacitor C6 for best square wave pattern on crt.

(8) Rotate VERTICAL VERNIER to CAL.

(9) Readjust output of AN/URM–207 for 10 cm crt deflection.

(10) Adjust capacitor C9 for best square wave pattern on crt.

(11) Repeat adjustment of C6 and C9 until best square wave pattern is obtained at the extreme VERNIER setting.

NOTE

There may be a capacitor in parallel with C9 which optimizes the adjustment range of C9. When changing V1 it may be necessary to alter the value of the capacitor, or add it if not present.

(12) Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

(13) Readjust output of AN/URM-207 for 10 cm crt deflection.

(14) Adjust capacitor C4 for best square wave pattern on crt.

(15) Set VERTICAL SENSITIVITY to 10 VOLTS/CM.

(16) Readjust output of AN/URM-207 for 10 cm crt deflection.

(17) Adjust capacitor C2 for best square wave pattern on crt.

(18) Rotate VERTICAL VERNIER fully counterclockwise.

(19) Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.

(20) Set VERTICAL AC-DC switch to AC.

(21) Set HORIZONTAL DISPLAY to 5 MSEC/CM.

(22) Set TRIGGER SOURCE to INT+.

(23) Turn TRIGGER LEVEL to AUTO.

(24) Using output of AN/URM-207, apply a 100-kHz square wave to vertical input terminals.

(25) Adjust AN/URM-207 output to give 10-cm deflection and center the pattern vertically.

(26) Using test oscilloscope, monitor the cathode of V3.

(27) Adjust C12 and C13 simultaneously, for the best square wave on both test oscilloscope and scope under test.

NOTE

Ignore the very fast overshoot at the leading edge as viewed on monitor scope. There may be a capacitor in parallel with C10 which optimizes the adjustment range of C10. When changing V1 or V2, it may be necessary to alter the value of the capacitor, or to add it if not present.

h. Calibrator Adjustment.

(1) Set VERTICAL SENSITIVITY to CAL.

(2) Turn VERTICAL VERNIER to CAL.

(3) Set HORIZONTAL DISPLAY to 1 μ-SEC/CM.

(4) Set TRIGGER SOURCE to INT−.

(5) Turn TRIGGER LEVEL to AUTO.

(6) Adjust potentiometer R51 for a crt deflection of 6 cm.

i. Horizontal Gain Adjustment.

(1) Set HORIZONTAL DISPLAY to 1 VOLTS/CM.

(2) Turn HORIZONTAL VERNIER to CAL.

(3) Using output of AN/URM-207, apply a 400-Hz 1-volt peak-to-peak signal to the horizontal input terminals.

(4) Adjust horizontal gain potentiometer R104 for a peak-to-peak crt deflection of 10 cm.

j. Horizontal Neutralizer Adjustment.

(1) Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

(2) Turn VERTICAL VERNIER to CAL.

(3) Set HORIZONTAL DISPLAY to 1 VOLTS/CM.

(4) Turn HORIZONTAL VERNIER to CAL.

(5) Using AN/URM-127, apply an 8-kc sine wave to vertical input terminals and the sync input of square wave generator.

(6) Using AN/URM-207, apply a 100-kc, 1-volt peak-to-peak square wave to horizontal input terminals.

(7) Adjust oscillator frequency to synchronize sine wave and square wave on crt (stabilize presentation).

(8) Adjust C103 and C104 for best square wave response.

k. Horizontal Frequency Compensation.

(1) Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

(2) Turn VERTICAL VERNIER to CAL.

(3) Turn HORIZONTAL VERNIER to CAL.

(4) Set HORIZONTAL DISPLAY to 1 VOLTS/CM.

(5) Using AN/URM-207, apply a 1-kc 10-volt, peak-to-peak square wave to horizontal input terminals.

(6) Using AN/URM-127, apply an 800-Hz, 10-volt peak-to-peak signal to the vertical input and sync input of square wave generator.

(7) Adjust oscillator to synchronize sine wave and square wave on crt (stabilize presentation).

(8) Adjust capacitor C235 for optimum square wave on crt.

l. Preset Adjustment.

(1) Set oscilloscope VERTICAL SENSITI-

VITY to CAL.

(2) Set HORIZONTAL DISPLAY to 5 μ-SEC/CM.

(3) Set TRIGGER SOURCE to INT+.

(4) Turn TRIGGER LEVEL just out of AUTO.

(5) Connect dc vtvm (100-volt range) between pin 2 of V202 and ground.

(6) Adjust potentiometer R258 (fig. 3–16) clockwise until crt sweep free-runs, then counterclockwise until the sweep just stops; note the reading on the dc vtvm.

(7) Adjust voltage to 3 volts less negative than the last reading.

m. Trigger Sensitivity Adjustment.

(1) Set oscilloscope VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.

(2) Set HORIZONTAL DISPLAY to 5 μ-SEC/CM.

(3) Turn both VERNIER controls to CAL.

(4) Set TRIGGER SOURCE to EXT.

(5) Turn TRIGGER LEVEL to AUTO.

(6) Set SWEEP MAGNIFIER to X5.

(7) Set VERTICAL and HORIZONTAL AC-DC switches to AC.

(8) Connect oscillator to both the vertical and horizontal inputs and set the frequency to 450 kc and amplitude to 0.16 volt rms (using ME–30B/U).

(9) Adjust R203 (trigger sensitivity) fully counterclockwise.

(10) Observing crt presentation, adjust R203 clockwise until the presentation becomes stable.

(11) Adjust oscillator output amplitude down to 0.1 volt rms; presentation should become slightly unstable between 0.15 and 0.10 volt rms.

(12) Set oscillator output amplitude to 0.5 volt rms, and adjust frequency from 50 Hz to 450 kHz. Presentation should remain stable across complete frequency range.

n. X1 Sweep Adjustment.

(1) Set oscilloscope VERTICAL SENSITIVITY to 1 VOLTS/CM.

(2) Turn VERTICAL VERNIER to CAL.

(3) Turn HORIZONTAL VERNIER to CAL.

(4) Set HORIZONTAL DISPLAY to 5 μ-SEC/CM.

(5) Set SWEEP MAGNIFIER to X1.

(6) Set TRIGGER SOURCE to INT−.

(7) Turn TRIGGER LEVEL to AUTO.

(8) Using AN/USM–207, apply 100-Hz time markers to the vertical input terminals.

(9) Adjust X1 sweep gain R267 to obtain 5 cycles per 10 cm on the crt.

o. Sweep Time Adjustment.

(1) Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

(2) Turn VERTICAL VERNIER to CAL.

(3) Turn HORIZONTAL VERNIER to CAL.

(4) Set TRIGGER SOURCE to INT−.

(5) Set SWEEP MAGNIFIER to X1.

(6) Connect STD FREQ connector of AN/USM–207 with 50-ohm load to the vertical input terminals.

(7) Referring to chart below adjust the AN/USM–207 output and the HORIZONTAL DISPLAY switch to the indicated marker interval and sweep time, respectively, for each step; adjust or check for the indicated markers per cm listed in the chart.

Step	Marker interval	AN/USM–207 STD FREQ OUT SWITCH POSITION	Sweep time	Adjust	Markers per 10 cm
1	10 μsec	105	5 USEC/CM	C227	5
2	10 μsec	105	10 USEC/CM	C227 [1]	10
3	10 μsec	105	20 USEC/CM	C227 [1]	20
4	100 μsec	104	50 USEC/CM	C225	5
5	100 μsec	104	100 USEC/CM	C225 [1]	10
6	100 μsec	104	200 USEC/CM	C225 [1]	20
7	1 ms	103	.5 MILLISECONDS/CM	C223	5
8	1 ms	103	1 MILLISECONDS/CM	C223 [1]	10
9	1 ms	103	2 MILLISECONDS/CM	C223 [1]	20
10	10 ms	102	5 MILLISECONDS/CM	R267	5
11	10 ms	102	10 MILLISECONDS/CM	R267 [1]	10
12	10 ms	102	20 MILLISECONDS/CM	R267 [1]	20
13	100 ms	10	50 MILLISECONDS/CM	R247	5
14	100 ms	10	100 MILLISECONDS/CM	R247 [1]	10
15	100 ms	10	200 MILLISECONDS/CM	R247 [1]	20

[1] Do not adjust if indication is within ±0.5 cm of that listed in the "markers per 10 cm" column.

p. Sweep Length Adjustment.

(1) Set oscilloscope VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.

(2) Turn VERTICAL VERNIER to CAL.

(3) Set VERTICAL AC-DC to AC.

(4) Set HORIZONTAL DISPLAY to 5 μ-SEC/CM.

(5) Turn HORIZONTAL VERNIER to CAL.

(6) Set SWEEP MAGNIFIER to X1.

(7) Set TRIGGER SOURCE to INT–.

(8) Turn TRIGGER LEVEL to AUTO.

(9) Adjust potentiometer R254 for a sweep length of 10.75 cm (minimum length on any range should be 10.5 cm).

4–31. Target Transmitter Alignment

Alignment of the target transmitter is required when a component has been repaired or replaced, or the unit has weak output and a defective component cannot be found.

a. Test Equipment Required. Refer to paragraph 4–3 for common names.

Federal stock No.	*Equipment*	*References*
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
5820–069–8915	Receiver, Radio R–725/URR	TM 11–5825–231–25

b. Alignment of Target Transmitter.

(1) Radio Transmitter T–279A/UR includes an rf oscillator followed by an rf amplifier. These two stages should track or tune together to the same resonant frequency for proper operation. With normal use of the transmitter, it is possible that one or more coils may require realignment at some time.

(2) For proper tracking, the rf oscillator and RF amplifier stages should have equal minimum capacities, and the inductances should be equal. The whip antenna is connected to the rf amplifier tuned circuit; therefore, the antenna capacitance of about 30 μμf is in parallel with tuning capacitor C612. Because the two ganged tuning capacitors have equal minimum capacities, trimmer capacitor C602 is connected in parallel with the oscillator tuning capacitor so that its minimum capacity can be adjusted to match the minimum capacitance of the rf amplifier stage. This capacitor determines the bandwidth or frequency ratio covered on each bank, and should not be readjusted unless absolutely necessary. If capacitor C602 is not properly adjusted, it will be impossible to align any of the coils so that the two stages tune together at both ends of the band.

(3) The frequency range of each rf oscillator coil is made to coincide with the dial calibration by means of a tuning slug in each coil. If the mechanical coupling between the dial drive and variable capacitor has not been tampered with, incorrect frequency calibration of the tuning dial indicates that realignment of the rf oscillator coils is necessary.

(4) After alignment of the rf oscillator coils, or when the current drawn by the rf amplifier stage is excessive, the rf amplifier coils must be realigned. The current drawn by the rf amplifier may be measured by disconnecting the +135-volt lead from the battery terminal strip and inserting TS–352B/U (set to 100 ma scale) in series with the circuit. The transmitter should be turned on, with the MCW-CW switch in the CW position. Turn the OUTPUT knob fully clockwise for maximum output. With new batteries, current readings at various frequencies should be close to those shown in the chart below:

Frequency (mc)	*Current (ma)*
.5	6.5
1	5
1	6
2	6
2	7
4	7
4	9
8	8
8	13
16	11
16	17
32	16

(5) Refer to figures 4–42 and 4–43 for the location of adjustable components.

c. Alignment of Rf Oscillator V601.

(1) Set the TRANSMITTER switch to OFF. Turn the radio transmitter on its side and remove the four knurled holddown screws on the bottom

(2) Extend the antenna to maximum height and set the TRANSMITTER switch to the ON position, the MCW-CW switch in the CW position, and turn the OUTPUT control fully counterclockwise. Refer to instructions in TM 11–688. Set the controls on the receiver to receive the cw signal from the transmitter.

(3) Set the receiver MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to obtain a reading of 0.5 mc on the frequency indicating dial. Set the transmitter BAND-SWITCH to 0.5-1MC and adjust the tuning control to read 0.5 mc on the tuning dial.

(4) Adjust the L601 tuning slug until the

transmitter signal received by the receiver is maximum as indicated by maximum deflection of the receiver LINE LEVEL and CARRIER LEVEL meters.

(5) Set the transmitter tuning control to read 1 mc on the tuning dial and set the receiver MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to read 1 mc on the frequency indicating dial. If the transmitter dial is incorrect at the opposite end of the dial, an incorrect setting of C602 is indicated.

NOTE

When capacitor C602 is not correctly adjusted, it will be impossible to make the dial calibrations correspond to the rf oscillator frequency on any band. Do not disturb the adjustment of C602 until the other bands have been checked.

(6) Repeat procedures given in (4) and (5) above for the band, frequencies, and coils shown in the table 4–1. The BANDSWITCH position discussed above is included in table 4–10.

Table 4–1. Target Transmitter—Coil Alignment (L601 through L606)

BANDSWITCH position	*Calibration frequencies (mc)*	*Coil*
.5–1MC	.5	L601
.5–1MC	1	
1–2MC	1	L602
1–2MC	2	
2–4MC	2	L603
2–4MC	4	
4–8MC	4	L604
4–8MC	8	
8–16MC	8	L605
8–16MC	16	
16–30MC	16	L606
16–30MC	30	

(7) If the rf oscillator does not correspond to the dial calibration on any band, adjust capacitor C602 as follows: If the rf oscillator frequency is too great, increase C602 until the range covered by the rf oscillator is decreased to the range shown on the dial; if the rf oscillator range is too narrow, decrease C602 until the range covered by the rf oscillator is increased to the range shown on the dial.

(8) After all bands have been aligned, recheck the frequency of each coil. Turn the TRANSMITTER switch to OFF.

d. Alignment of Rf Amplifier V602.

(1) Insert multimeter in the positive 135-volt line as directed in *c*(4) above. Extend the antenna to maximum height.

(2) Set the TRANSMITTER switch to ON, the MCW-CW switch to CW, and turn the OUTPUT knob clockwise for maximum output.

(3) Set the BANDSWITCH on the 0.5-1MC position and vary the tuning control to read .5 mc on the tuning dial. Vary the tuning slug of L607 to obtain minimum plate current as read on the multimeter.

(4) Vary the tuning control to obtain a reading of 1 mc on the tuning dial and check to see that L607 also is tuned at this frequency for minimum plate current by varying the slug. If the two adjustments differ slightly, readjust the slug of L607 by a small amount so that the plate currents are equal on both frequencies.

(5) Repeat procedures given in (3) and (4) above for the bands, frequencies, and coils shown in table 4–2.

Table 4–2. Target Transmitter—Coil Alignment (L607 through L612)

BANDSWITCH Position	*Calibration frequencies (mc)*	*Coil*
.5–1MC	.5	L607
.5–1MC	1	
1–2MC	1	L608
1–2MC	2	
2–4MC	2	L609
2–4MC	4	
4–8MC	4	L610
4–8MC	8	
8–16MC	8	L611
8–16MC	16	
16–30MC	16	L612
16–30MC	30	

CHAPTER 5

MAINTENANCE INSTRUCTIONS FOR DIRECTION FINDER SET AN/TRD-15(*)

Section I. INTRODUCTION

5-1. Scope of Maintenance Instructions (AN/TRD-15(*))

a. This chapter presents procedures for the organizational, direct support, and general support maintenance of Direction Finder Set AN/TRD-15(*).

b. Unless otherwise stated in this chapter, all instructions for Direction Finder Set AN/TRD-23(*) presented in chapters 1 through 4 of this manual apply to the AN/TRD-15(*).

5-2. Organization of the Chapter

a. Each section (I through IV) of this chapter corresponds to a chapter (1 through 4) of the instructions for the AN/TRD-23(*).

b. A listing of the information in chapters 1 through 4 which applies direct to the AN/TRD-15(*) is presented at the beginning of each section, followed by detailed information which applies only to the AN/TRD-15(*).

5-3. Items Not Covered

a. The maintenance of monitor Oscilloscope AN/USM-318(V)1 is covered in TM 11-6625-1703-15 and chapter 8.

b. A shelter is not supplied with the AN/TRD-15(*). For shelter maintenance, refer to the manual for the shelter used.

5-4. Internal Differences in Models

Units which differ between the AN/TRD-15 and AN/TRD-15A are listed below. Details of the variations between individual units are discussed in Chapter 2.

Unit	*AN/TRD-15*	*AN/TRD-15A*
Radiofrequency Detector	RF-159/TRD	RF-159A/TRD
Drive-Rotary Coupler Goniometer	TG-126/TRD	TG-126A/TRD
Monitor oscilloscope	HP120B	AN-USM-318(V)1

5-5. Differences Between AN/TRD-23(*) and AN/TRD-15(*)

a. The AN/TRD-15(*) is operationally similar to the AN/TRD-23(*).

b. The AN/TRD-15(*) does not include a communications console, monitor receivers, transmitter or teletypewriter provisions, antenna coupler, or a shelter.

c. The following is a list of units in both versions of the equipment.

Unit	*AN/TRD-23(*)*	*AN/TRD-15(*)*
Antenna System AN/TRA-32	1	1
Coupler, Antenna CU-1874/TRD-23A	1	0
Drive, Goniometer-Rotary Coupler TG-126(*)/TRD	1	1
Amplifier, Electronic Control AM-3545/TRD	1	1
Receiver, Radio R-725/URR	8	4
Detector, Radiofrequency RF-159(*)/TRD	2	2
Power Supply PP-4482/TRD	2	2
Indicator, Azimuth IP-669/TRD	2	2
Panel, Power Distribution SB-1747/TRD	1	1
Oscilloscope, monitor (two models)	1	1
Distribution box, audio (four models)	3	0
Equipment consoles (five models)	3	2
Shelter S-280A/G	1	0
Transmitter, Radio T-279A/UR	1	1

Section II. FUNCTIONING OF EQUIPMENT

5-6. System Block Diagram
(fig. 5-1)

a. Direction Finder Set AN/TRD-15(*) has two signal sources, the monitor antenna and the df antenna.

b. The monitor antenna can be connected to any or all four df receivers, depending upon the mode of operation selected.

c. For information about signal processing through the system, refer to paragraph 2-2.

5-7. Unit Functioning
Operation for each unit is presented in section II of chapter 2. Paragraphs 2-4, antenna coupler, and 2-15, audio boxes, do not apply to the AN/TRD-15(*).

5-8. Interunit Circuit Details
a. Equipment Consoles. The AN/TRD-15(*) uses two equipment consoles:

Console	*AN/TRD-15(*)*
Primary	CY-4873/TRD
Secondary	CY-4873/TRD

b. Equipment Location. Figure 5-2 shows the location of the various units in the two consoles. Power for all the units is controlled by the power panel.

c. Signal Voltage Distribution (fig. 5-1, FO-16, FO-17, and FO-18).

(1) Rf signals (1.5 to 20 MHz) intercepted by the antenna system enter through the antenna input panel in the primary console.

(2) The monitor antenna supplies signal direct to the No. 2 df receivers and also to the No. 1 df receivers (in the MONITOR mode) through the MONITOR-D.F. relays in the goniometer drive chassis.

(3) The monitor oscilloscope receives the if. output of the No. 1 df receiver in the primary console, as well as the pulse from the sync pulse generator in the goniometer drive.

(4) The other signals in the AN/TRD-15(*) are routed as in the AN/TRD-23(*).

d. Console Power.

(1) Console power enters the power panel in the primary console at J2.

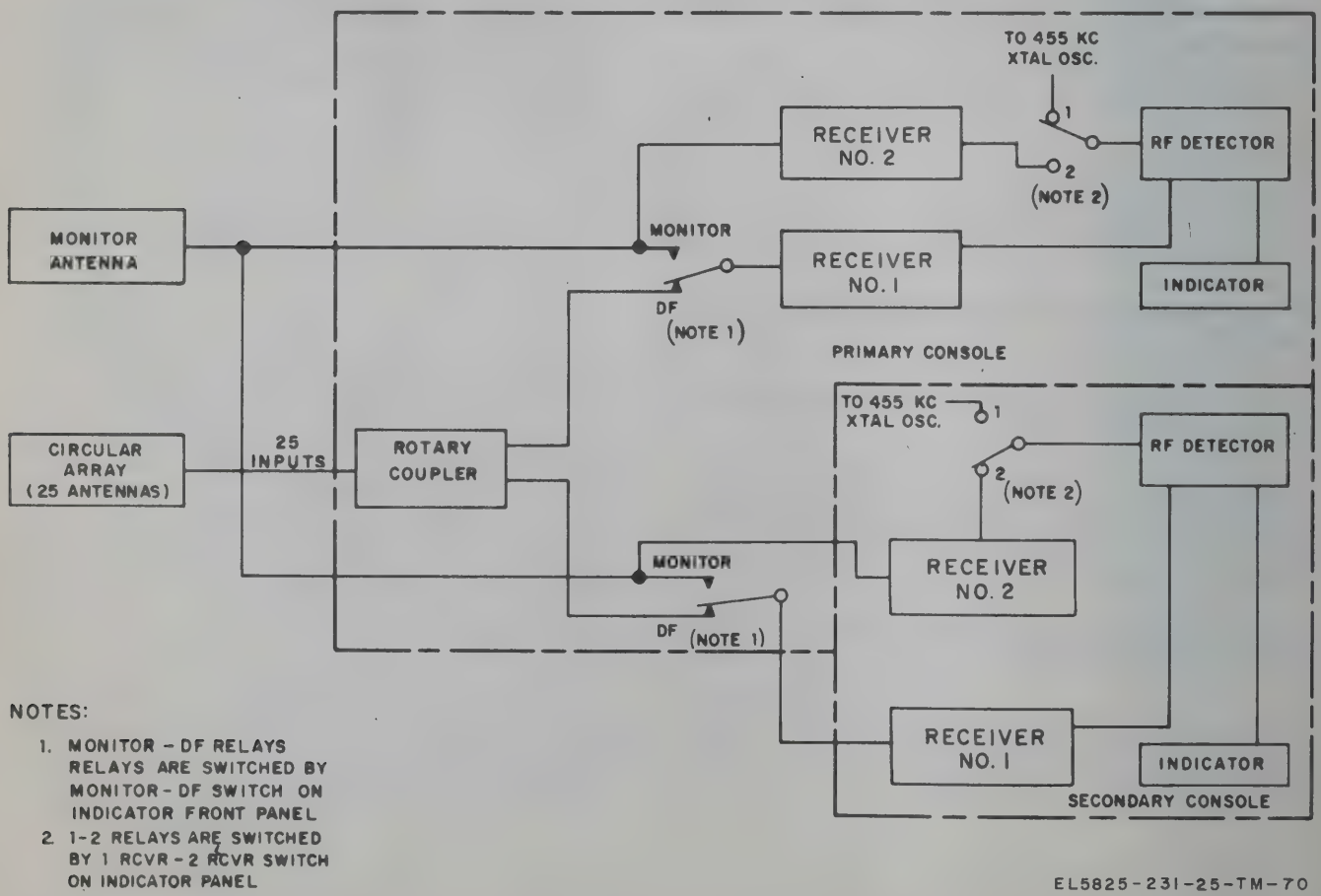


Figure 5-1. Direction Finder Set AN/TRD-15(*), system block diagram.

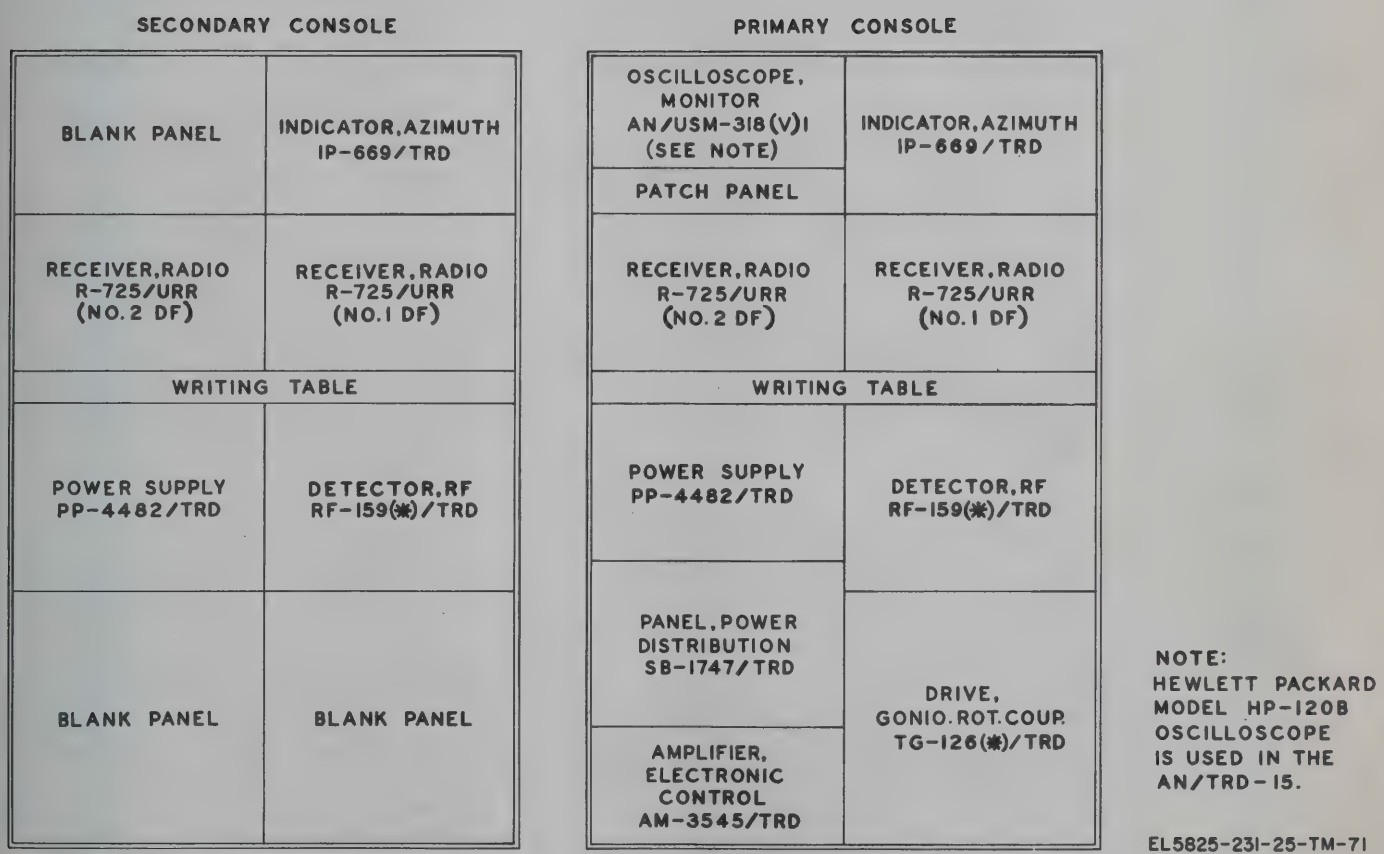


Figure 5-2. Direction Finder Set AN/TRD-15(*), location of components.

(2) All units in both consoles are controlled by the power panel through power interconnections as shown in figures FO-16, FO-17, and FO-18.

Section III. ORGANIZATIONAL, DS, GS, AND FINAL TESTING

5-9. Organizational Maintenance

Organizational maintenance for the AN/TRD-15(*) is identical with that of the AN/TRD-23(*). See chapter 3 for preventive maintenance and troubleshooting instructions.

5-10. DS, GS, and Final Testing

a. Troubleshooting, repair and alignment of units of the AN/TRD-15(*) is identical with that of the AN/TRD-23(*).

b. Procedures for GS, DS, and final testing of the AN/TRD-15(*) are given in chapter 4. The following paragraphs do not apply to the AN/TRD-15(*):

Unit	*Instruction*	*Paragraph*
Antenna coupler	Troubleshooting	4-5
Antenna coupler	Repair	4-16
Antenna coupler	Alignment	4-23

CHAPTER 6

SHIPMENT, LIMITED STORAGE, AND DEMOLITION

6–1. Disassembly and Repacking of Equipment

a. Disassembly. Instruction for disassembly of the AN/TRD–15(*) and AN/TRD–23(*) are given in TM 11–582–231–10. Refer to the manual for the shelter used with the AN/TRD–15(*) for instructions on its disassembly.

b. Repacking. Repackaging of equipment for shipment or limited storage normally will be performed at a packaging facility or by a repackaging team. If emergency packaging is required, select the materials from those listed in SB 38–100. Package the equipment in accordance with the original packaging, as much as possible, with the available materials.

6–2. Demolition to Prevent Enemy Use

Demolition of Direction Finder Sets AN/TRD–23(*) and AN/TRD–15(*) will be accomplished only upon order of the commander. Use the destruction procedures outlined in TM 11–5825–231–10 to prevent further use of the equipment.

Item No.	*Name*	*No. per unit*	*Ref. symbol*
1	Housing, goniometer	1	MP1A
2	Plate, goniometer side	2	MP40
3	Slot, mounting (for MP32)	2	
4	Hole, mounting (for MP43 in MP1A face)	3	
5	Washer, spring	1	MP45
6	Bearing, rear goniometer shaft	1	MP14
7	Coil, coupling (rotor of T1)	1	
8	Rotor assembly, goniometer	1	E9
9	Plate, shaft retaining, goniometer	1	MP41
10	Holes, mounting (for MP42 screws)	3	
11	Bearing, front goniometer shaft	1	MP15
12	Shaft, goniometer (part of E9)	1	
13	Coupler, flexible	1	MP23
14	Setscrew (in MP23)	2	
15	Setscrew (in MP23)	2	
16	Mount, rubber shock	4	MP29
17	Plate, shock mounting	1	
18	Plate, drive mounting	1	MP17
19	Setscrew (in MP21)	2	
20	Pulley, timing belt	1	MP21
21	Bolt, hex.	2	MP32
22	Housing, drive, secondary goniometer	1	MP28
23	Hole, mounting (in MP28)	4	
24	Clamp, mounting	4	MP30
25	Flange, mounting, sync assembly	1	MP8
26	Housing, sync stator (houses Coil L1)	1	MP8A
27	Housing, sync assembly	1	MP34
28	Screw, mounting, sync housing	6	MP35
29	Ring, shaft retaining	1	MP14
30	Bearing, spacer	1	MP6
31	Shaft, sync assembly	1	MP7
32	Magnet, sync rotor	1	E12
33	Rotor, sync assembly	1	MP5
34	Plate, sync assembly back	1	MP36

Item No.	Name	No. per unit	Ref. symbol
1	Stator, rotary coupler (input coils)	1	E1
2	Plate, shim spacing	2	MP8
3	Rotor assembly, rotary coupler (output coils)	1	E3
4	Shaft, rotor (threaded for MP9)	1	MP2
5	Screw, stator mounting	5	MP46
6	Housing, rotary coupler	1	MP2A
7	Bolt, rear motor mounting	5	MP31
8	Locknut	1	MP9
9	Coupler, flexible	1	MP24
10	Setscrew (in MP24)	4	
11	Connector, plug, electrical	1	P1
12	Motor, synchronous	1	B1
13	Bolt, front motor mounting	4	MP33
14	Shaft, motor (part of B1)	1	
15	Hole, housing mount (base of MP28)	4	
16	Housing, drive, primary goniometer	1	MP28
17	Face, mounting (part of MP28)	1	
18	Pulley, timing belt	1	MP21
19	Belt, timing	1	MP22
20	Coupler, flexible	1	MP23
21	Setscrew (in MP23)	4	
22	Shaft, goniometer (part of rotor E9)	1	
23	Plate, shaft retaining, goniometer	1	MP41
24	Face, goniometer mounting (part of MP1A)	1	
25	Setscrew, goniometer stator adjusting	3	MP39
26	Connector, rf, goniometer stator	4	J1, J2, J3, J4
27	Screw, goniometer stator mounting	3	1 of MP37; 2 of MP38
28	Hole, goniometer sideplate mounting	6	
29	Stator, goniometer (inside housing)	1	E11
30	Stator, coupling coil (inside housing, part of T1)	1	
31	Connector, rf, T1 stator	1	J5
32	Plate, goniometer top cover	1	MP43

NOTES

1. Goniometer rotor assembly contains goniometer rotor coil and rotor coil of coupling transformer T1.
2. Stator coil of coupling transformer T1 is located on inside rear of goniometer, and has same reference symbol as rotor.

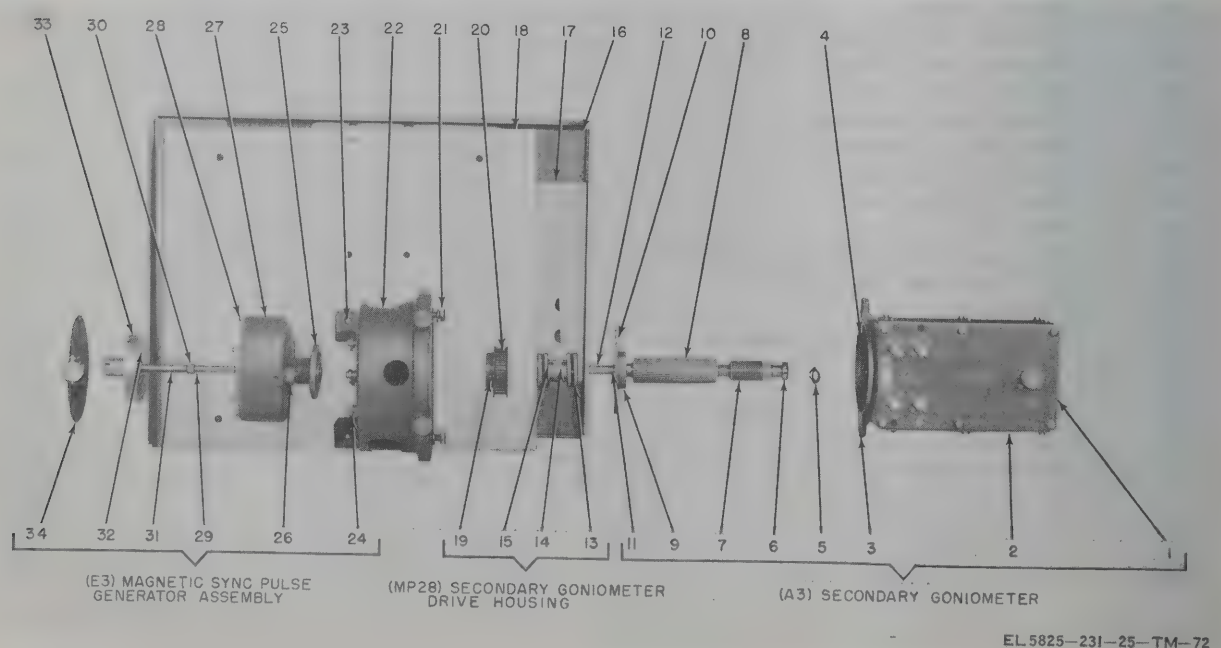

33 30 28 27 25 23 22 21 20 18 17 16 12 10 8 4
34 32 31 29 26 24
19 15 14 13
11 9 7 6 5 3 2 1
(E3) MAGNETIC SYNC PULSE GENERATOR ASSEMBLY
(MP28) SECONDARY GONIOMETER DRIVE HOUSING
(A3) SECONDARY GONIOMETER
EL 5825-231-25-TM-72

Figure 6-1. Secondary goniometer, drive housing and sync assembly, exploded view.

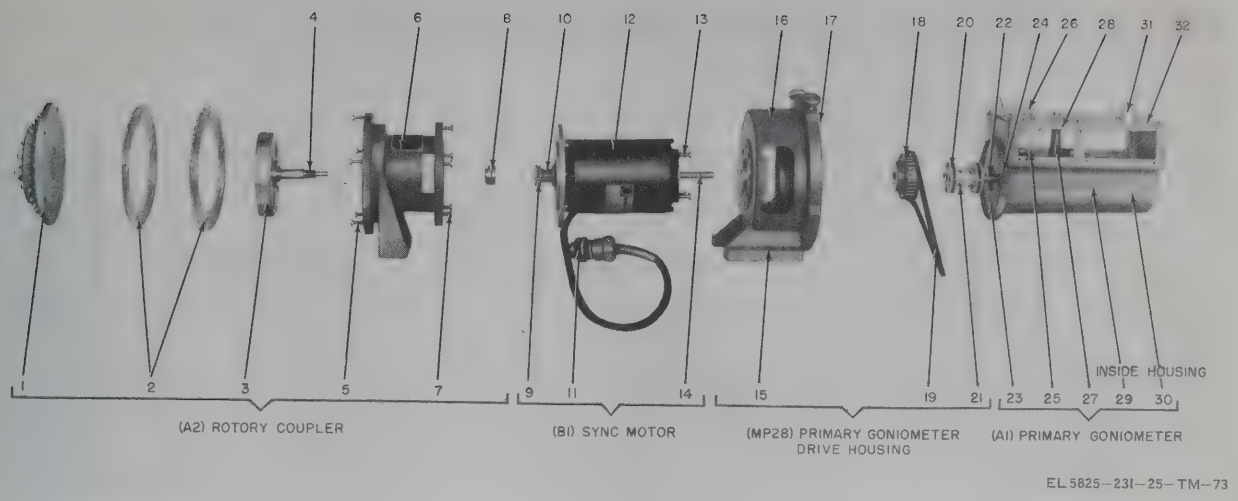
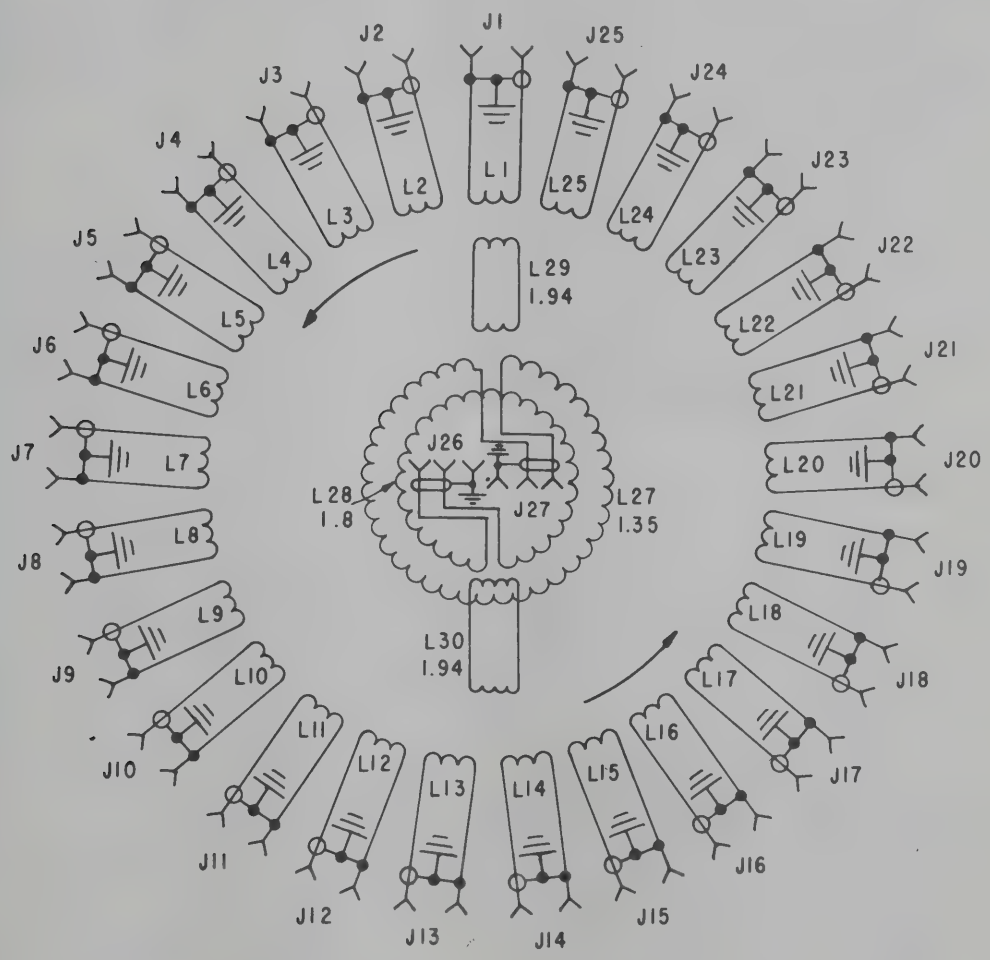


Figure 6-2. Primary goniometer, drive housing and sync assembly, exploded view.



NOTES:

1. UNLESS OTHERWISE SHOWN, ALL INDUCTANCES ARE IN MICROHENRIES
2. VALUE OF L1 THRU L25 IS 1.52

EL5825-231-25-TM-75

Figure 6-3. Rotary coupler, schematic diagram.

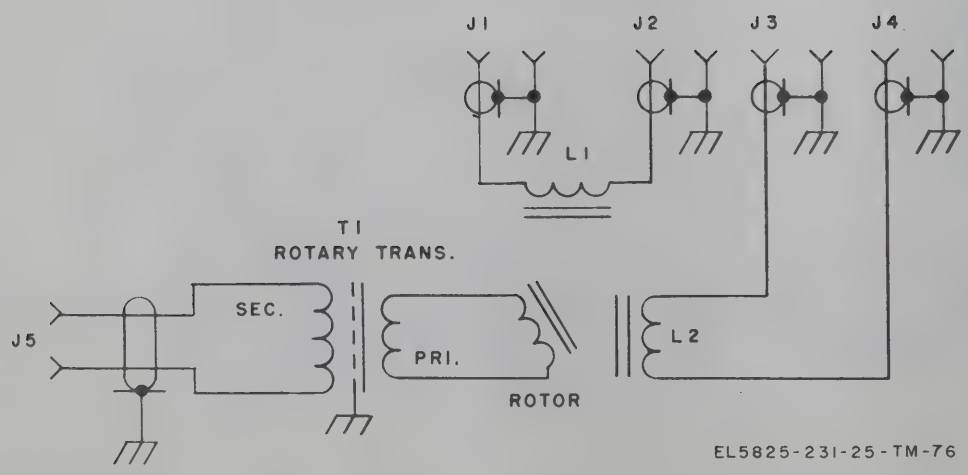


Figure 6-4. Goniometer, schematic diagram.

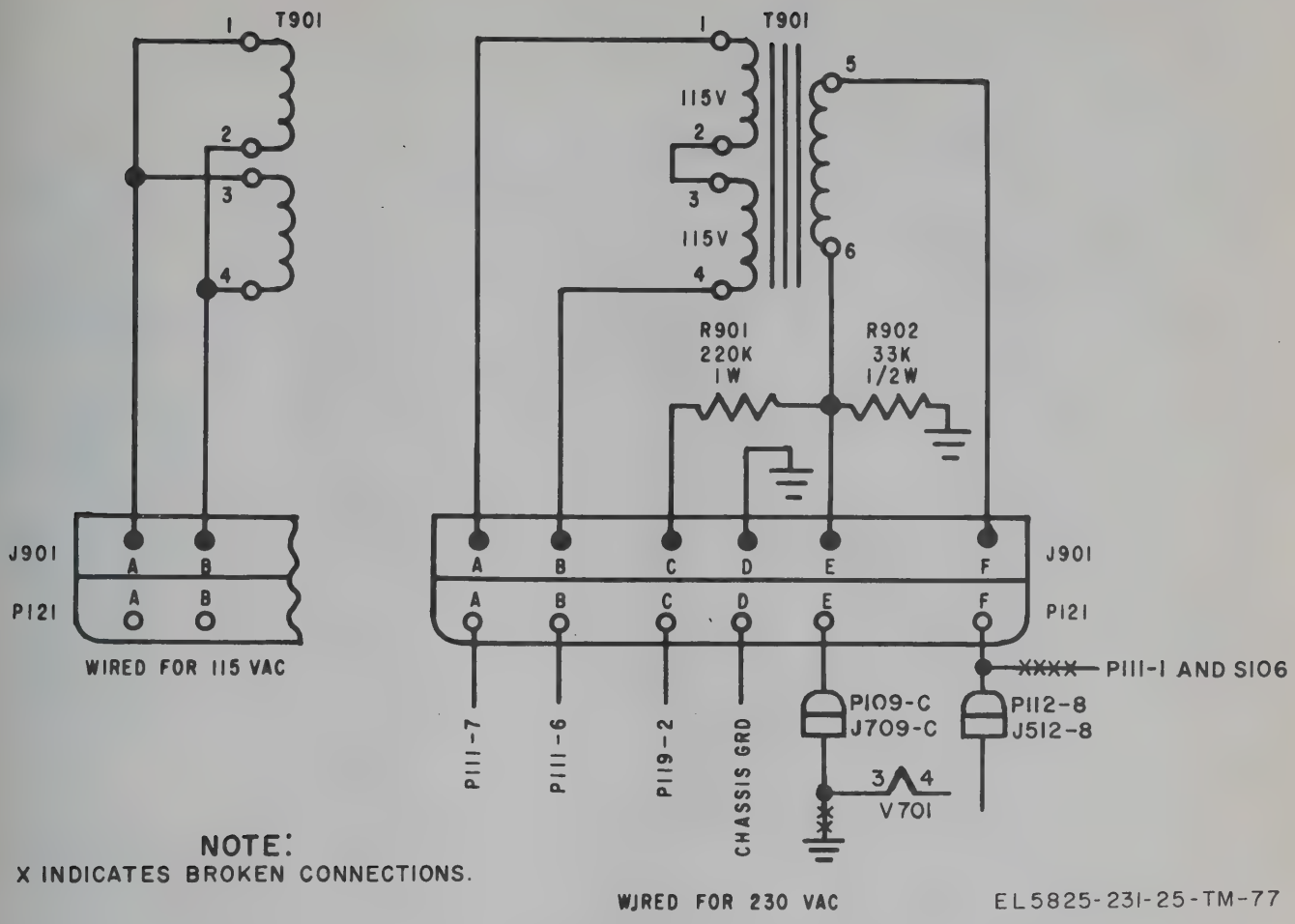


Figure 6-5. R-390A/URR receiver modification.

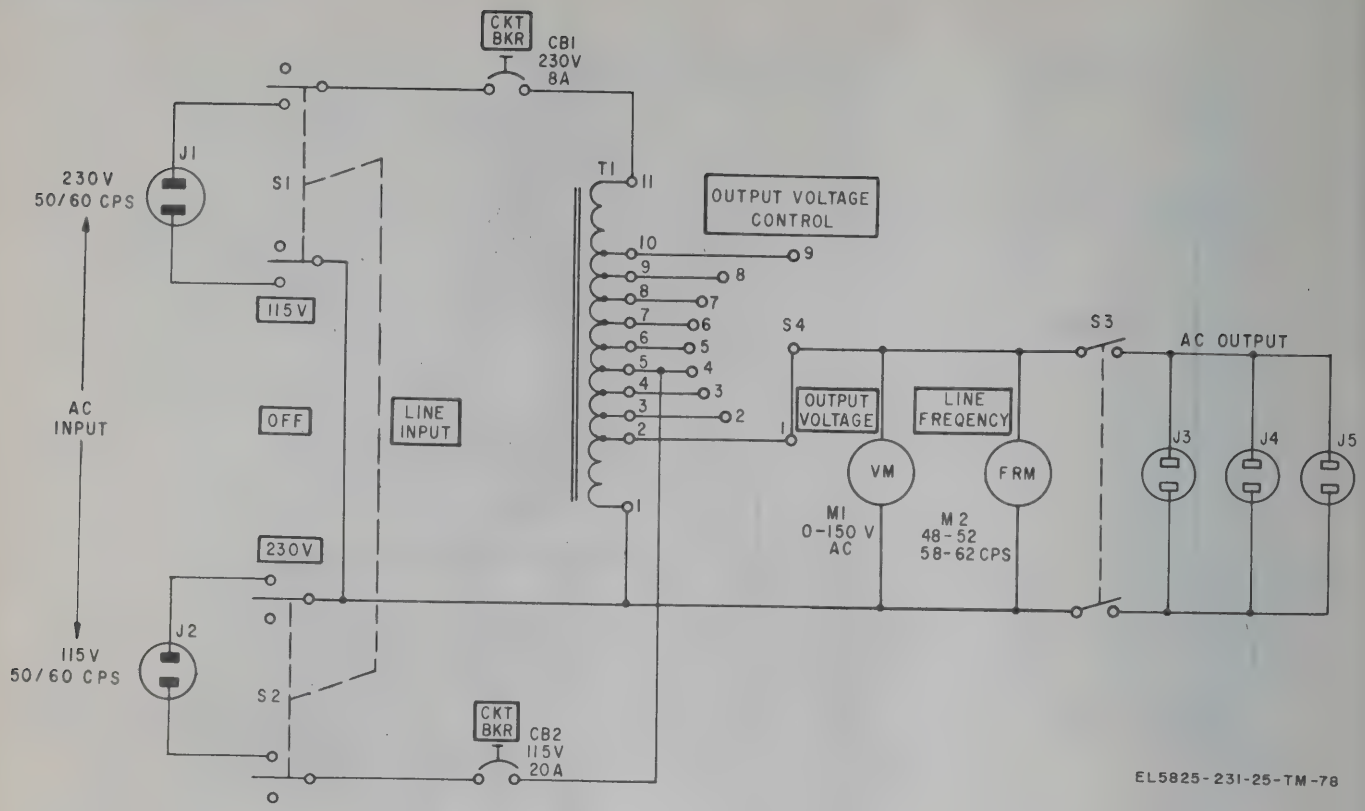


Figure 6–6. Power distribution panel, schematic diagram.

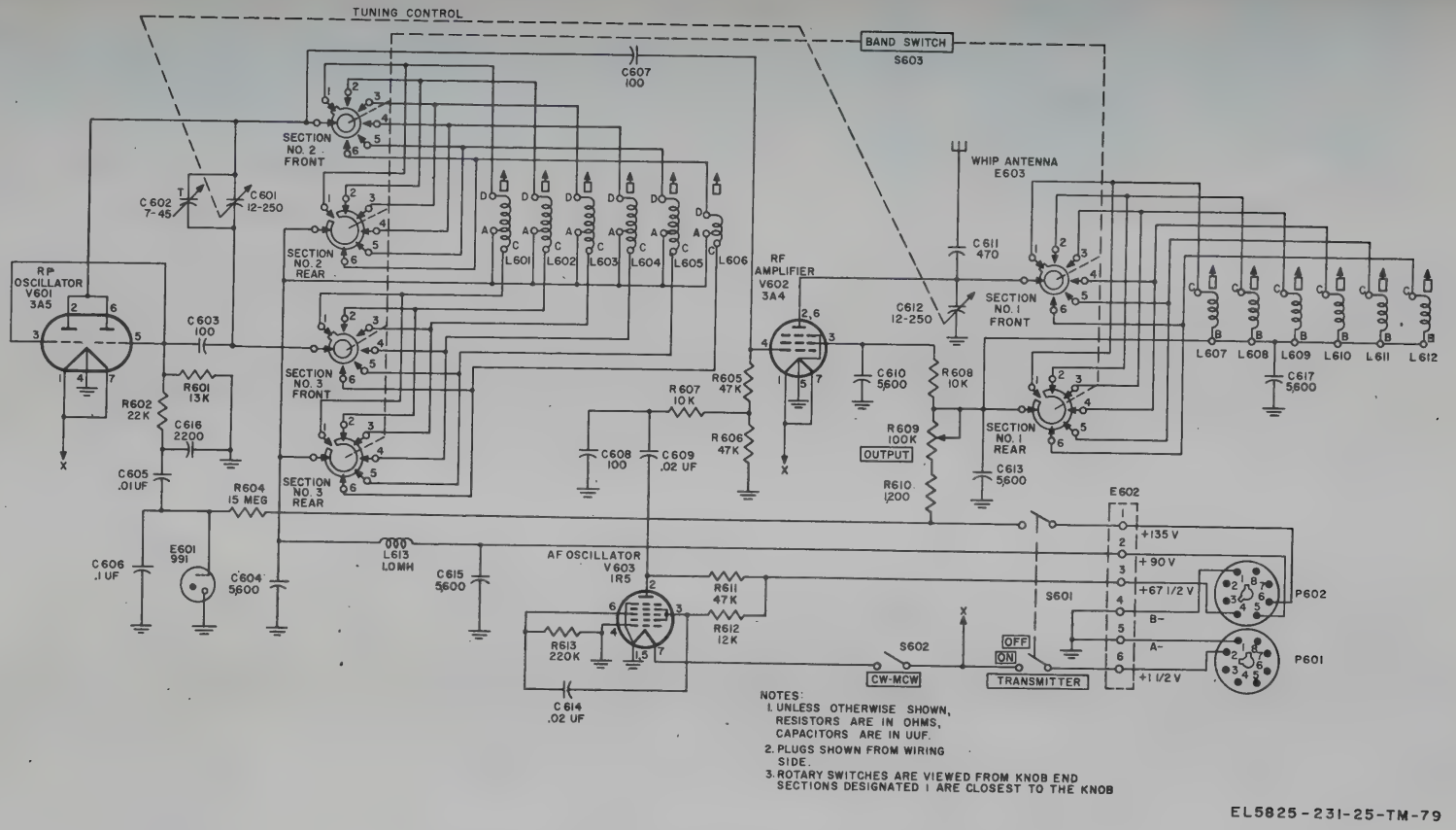
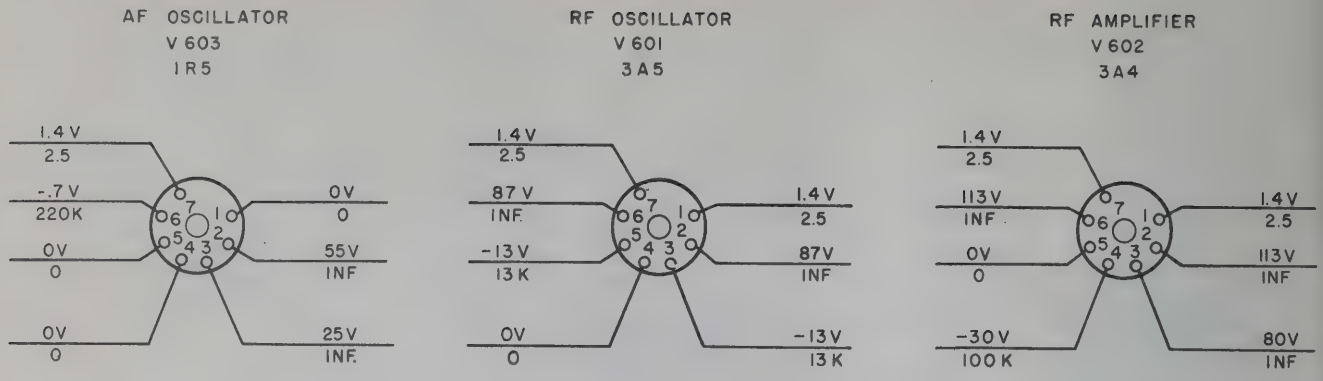


Figure 6–7. Transmitter, Radio T–279/UR, schematic diagram.



NOTES

1. ANTENNA IS FULLY EXTENDED.
2. BAND SWITCH IS ON BAND 3.
3. TUNING DIAL IS SET TO 3MC.
4. MCW-CW SWITCH IS ON MCW.
5. OUTPUT CONTROL IS TURNED FULL CLOCKWISE FOR MAXIMUM OUTPUT.
6. TRANSMITTER SWITCH IS TURNED ON.
7. BATTERY PLUGS ARE DISCONNECTED FOR RESISTANCE MEASUREMENTS ONLY.
8. BOTTOM VIEWS OF SOCKETS ARE SHOWN.
9. VOLTAGES AND RESISTANCES MEASURED TO GROUND WITH A 20,000 OHMS-PER-VOLT METER. USE HIGHER METER RANGES TO PREVENT CIRCUIT LOADING.
10. RESISTANCES ARE IN OHMS, K INDICATES 1,000.
11. NM INDICATES NOT MEASURABLE.
12. NC INDICATES NO CONNECTION.
13. INF INDICATES INFINITE.

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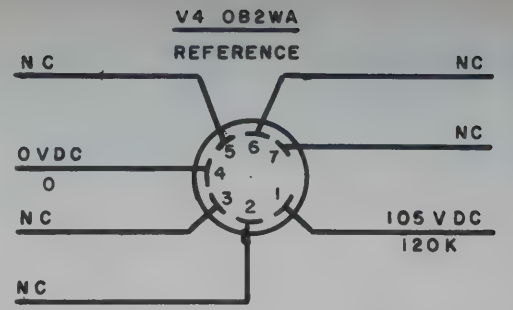
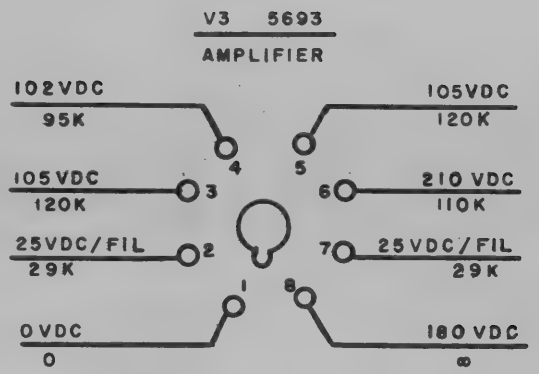
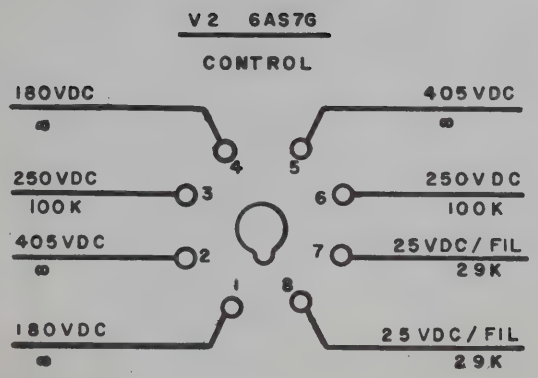
Figure 6–8. Transmitter, Radio T–279/UR, vr measurements.

NOTES:

1. ALL VOLTAGES AND RESISTANCES MEASURED WITH MULTIMETER, SIMPSON MODEL 260 FROM TERMINAL INDICATED TO CHASSIS GROUND.
2. NC INDICATES NO CONNECTION.
3. DASH (—) INDICATES NO MEASUREMENT SHOULD BE TAKEN.
4. FIL INDICATES FILAMENT TERMINALS ACROSS WHICH 6.3 VAC SHOULD BE MEASURED.
5. FIL.* INDICATES FILAMENT TERMINALS ACROSS WHICH 5.0 VAC SHOULD BE MEASURED.







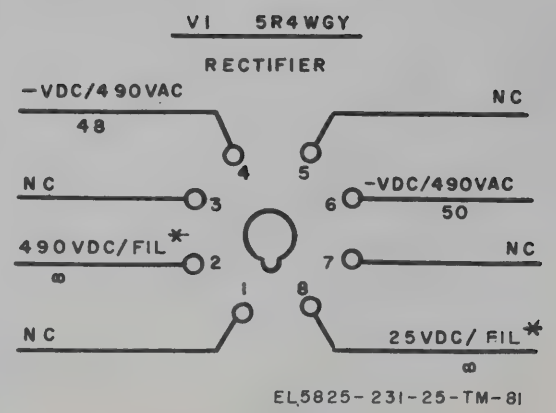


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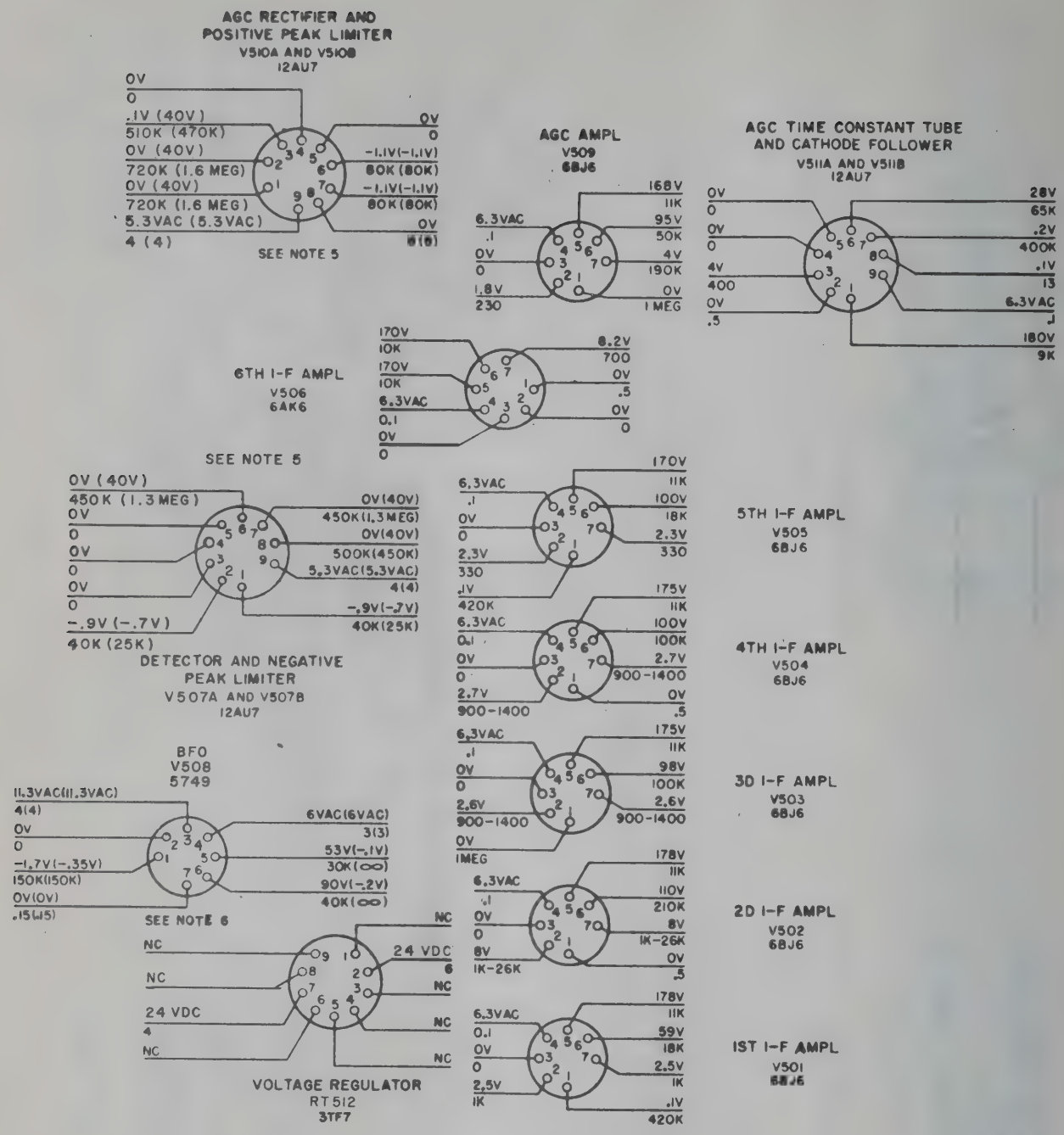
Figure 6–9. Power supply, vr measurements.



1. UNLESS OTHERWISE SHOWN,
   RESISTORS ARE IN OHMS AND ARE MEASURED FROM PIN SOCKET TO GROUND WITH A 20,000 OHMS-PER-VOLT METER (SUCH AS MULTIMETER TS-352/U).
   VOLTAGES ARE DC AND ARE MEASURED FROM PIN SOCKET TO GROUND WITH A VTVM (SUCH AS ELECTRONIC MULTIMETER TS-505/U).
   READINGS ARE THE SAME ON ALL BANDS.
2. NC INDICATES NO CONNECTION.
3. ∞ INDICATES INFINITY.

NOTES:

4. UNLESS OTHERWISE NOTED, SET CONTROLS AS FOLLOWS:
   SET S801 TO 115 VOLTS AC, [FUNCTION] TO [AGC], [AUDIO RESPONSE] TO [MED], [RF GAIN] TO [10], [LOCAL GAIN] TO [10], AND [BANDWIDTH] TO [8KC].
5. READINGS IN PARENTHESES ARE MADE WITH [LIMITER] AT [OFF], OTHER READINGS ARE WITH [LIMITER] AT [10].
6. READINGS IN PARENTHESES ARE MADE WITH [BFO] AT [OFF].

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Figure 6-10. If. subchassis, vr measurements.

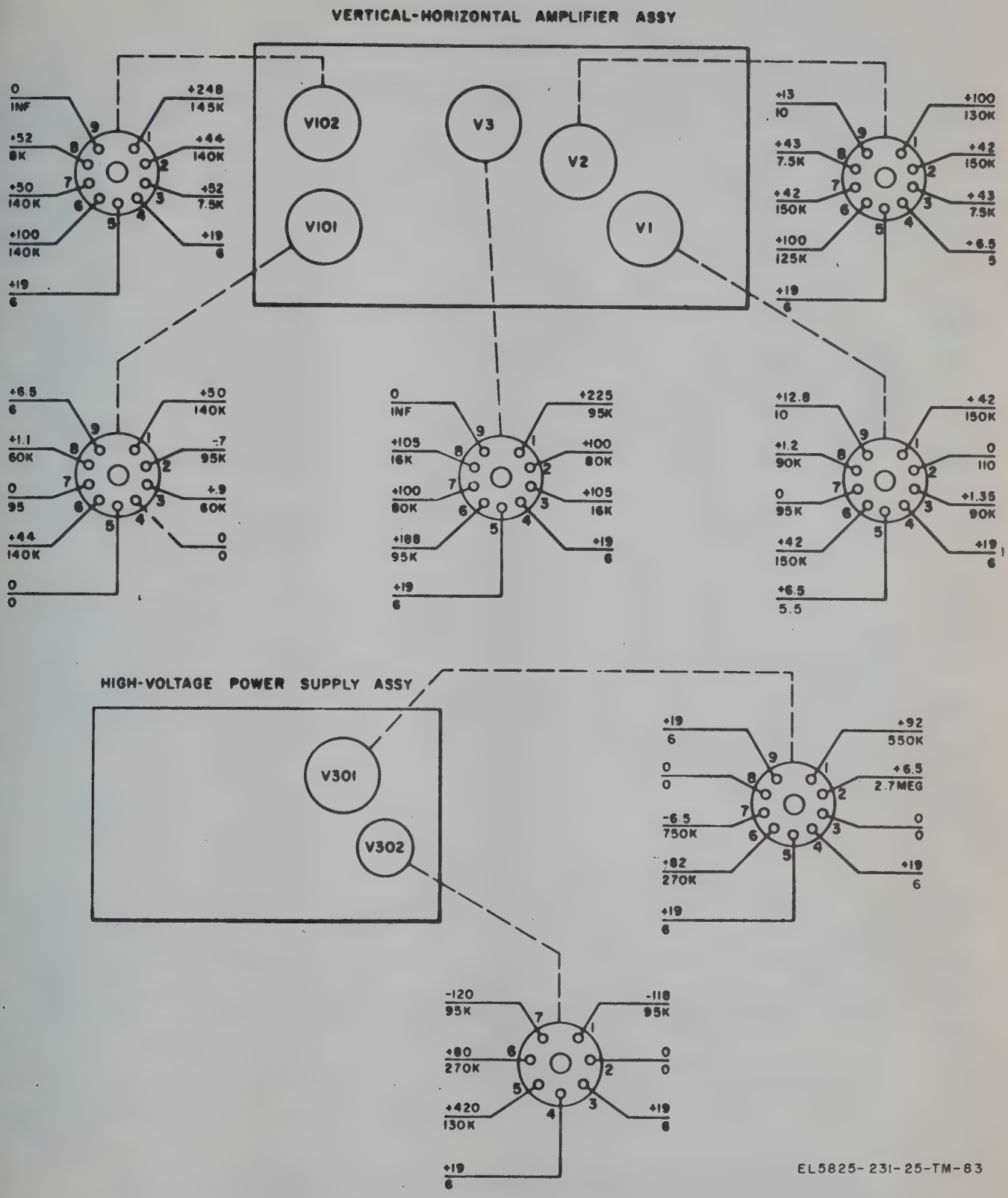


Figure 6–11. Vertical-horizontal amplifier, oscilloscope 120B, vr measurements.

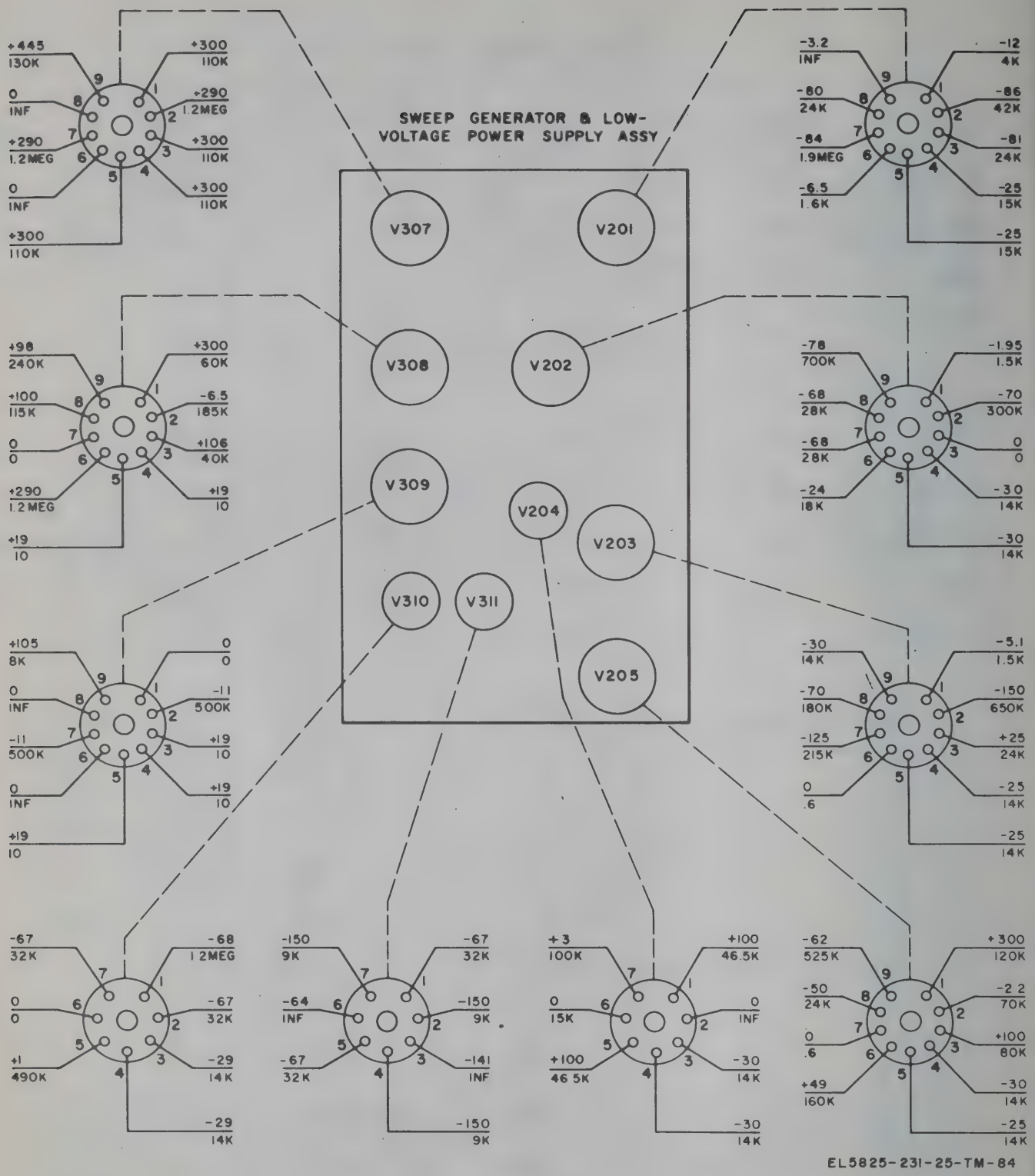


Figure 6-12. Sweep generator and low-voltage power supply 120B, measurements.

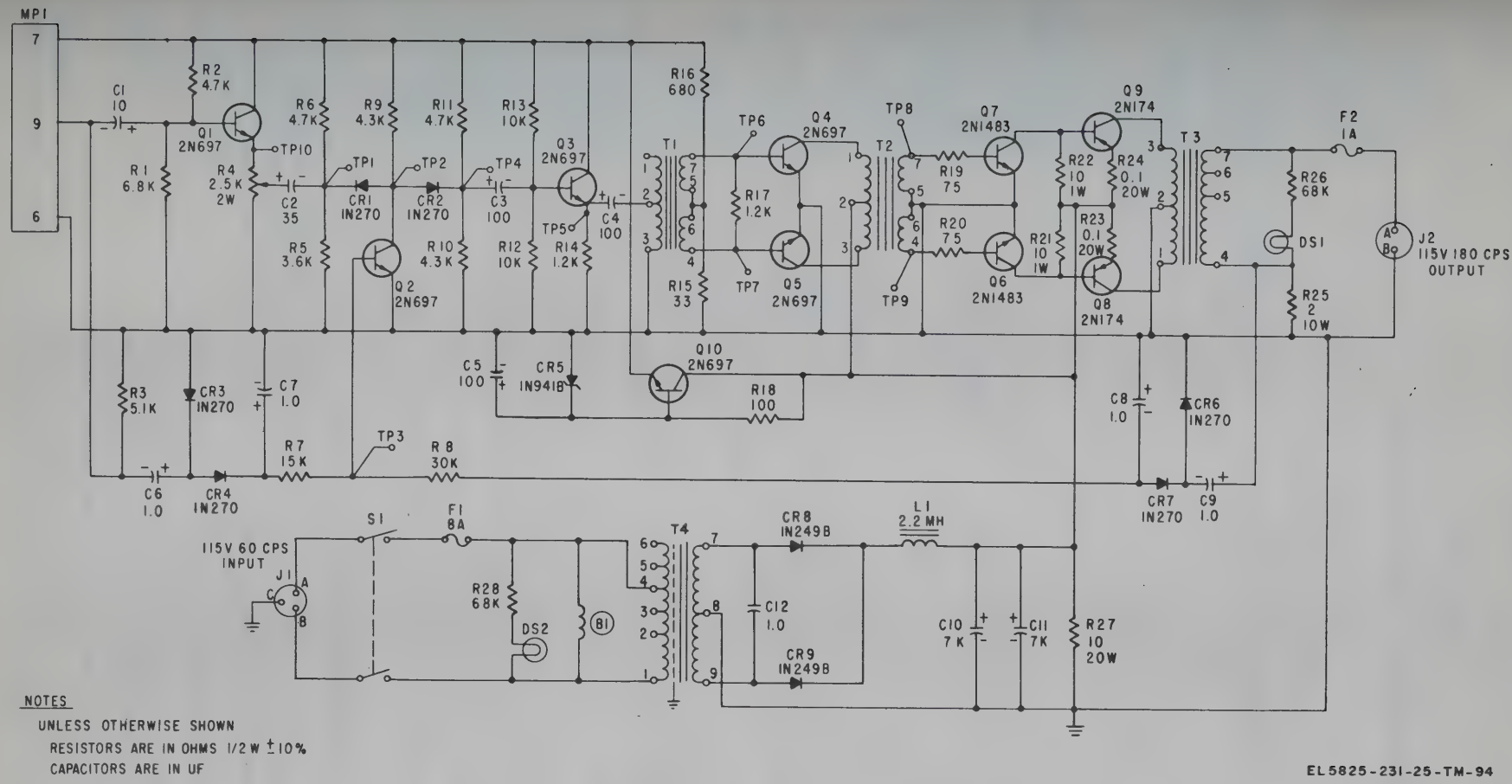


Figure 6–13. Electronic control amplifier, schematic diagram.

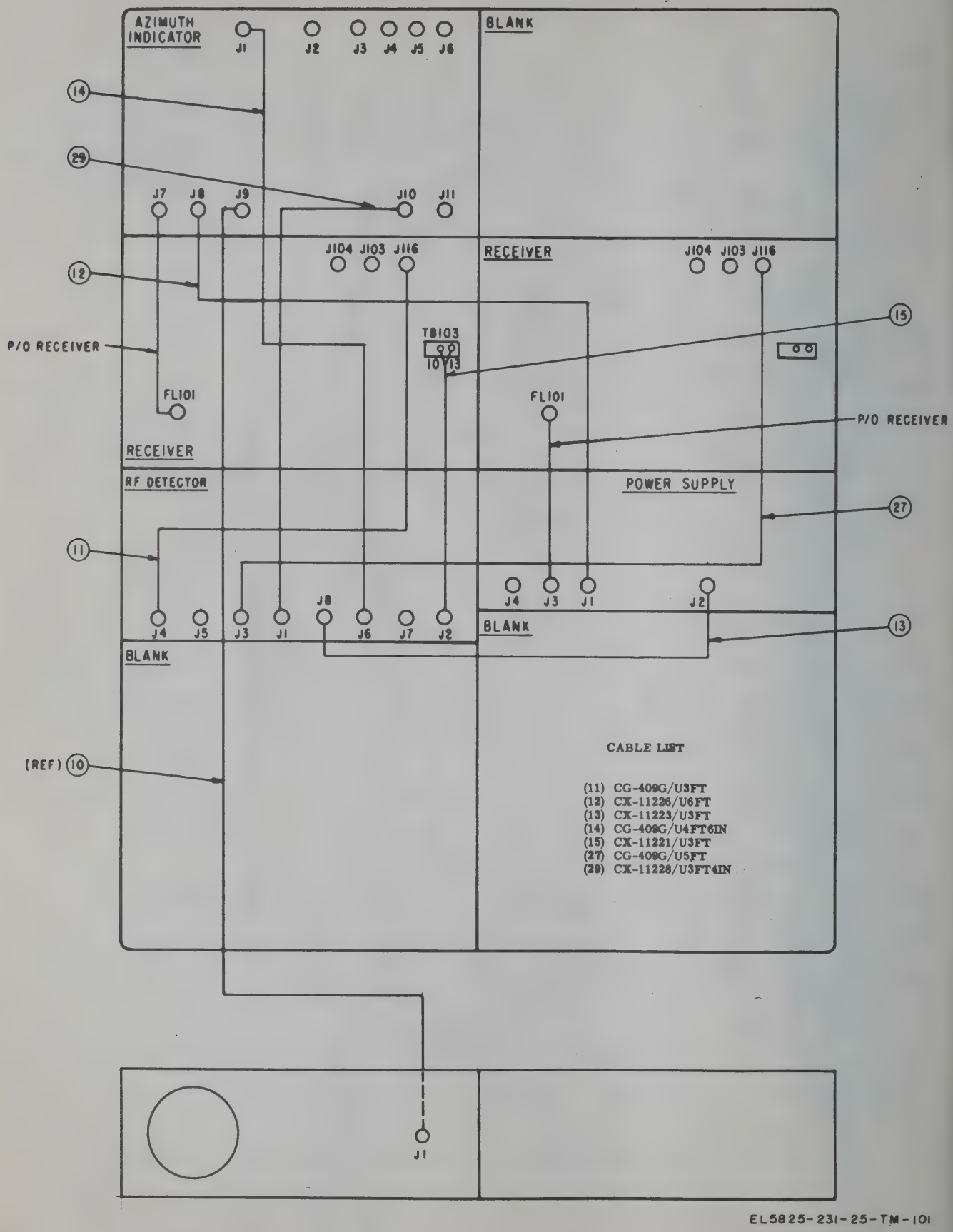


Figure 6–14. AN/TRD–15(*), secondary console, cabling diagram.

CHAPTER 7

FINAL TESTING PROCEDURES

Section I. GENERAL

7–1. Purpose of Tests

The tests outlined in this chapter are designed to measure the performance capability of a repaired unit. Equipment that meets the minimum standards in the tests will furnish satisfactory operation, equivalent to that of new equipment.

7–2. Test Equipment Required

a. Test Equipment.

Federal stock No.	*Equipment*	*Common names*	*References*
6625–553–0142	Multimeter TS–352B/U	Multimeter	TM 11–6625–366–15
6625–643–1670	Voltmeter, Electronic ME–30B/U	Ac VTVM	TM 11–6625–320–12
6625–783–5965	Generator, Signal AN/URM–127	Audio signal generator	TM 11–6625–683–15
6625–911–6368	Counter, Electronic Digital Readout AN/URM–207	Counter	TM 11–6625–700–10
6625–228–2201	Oscilloscope AN/USM–281A	Oscilloscope	TM 11–6625–1703–15
6625–868–8353	Generator, Signal AN/GRM–50	Rf generator	TM 11–6625–573–15
5950–235–2086	Transformer, Power, Variable CN–16/U	Variac	
6625–868–8352	Generator, Signal AN/URM–103	Fm signal generator	TM 11–6625–586–12
5820–069–8915	Receiver, Radio R–725/URR	Receiver	TM 11–5825–231–25
6625–913–9781	Multimeter ME–26B/U	Dc vtvm	TM 11–6625–200–15
NSN	Attenuator PA–10 (Microlab), or equivalent, 72 ohm, 10 dB, 2 W, 2 kw peak	Attenuator	
NSN	Power combiner DA–3 (Microlab), or equivalent, 50 ohm, 3 arm 2 w average	Power combiner	
NSN	Filter, bandpass (BURNELLNYTRONICS) S–54655 (18–32 MHz)	Bandpass filter	
	Voltmeter, Electronic AN/URM–145	Sweep generator	TM 11–6625–524–14
	Radio Interference Measuring Set AN/URM–85	Field strength meter	TM 11–6625–351–12
NSN	Phase angle voltmeter, ADYU Electronics Model 524	Phase angle voltmeter	

b. Direction Finder Set AN/TRD–15(*), AN/TRD–23(*) Units.

Equipment	*Common name*
Amplifier, Electronic Control AM–3345/TRD	Control amplifier
Drive, Goniometer-Rotary Coupler TG–126(*)/TRD	Goniometer drive
Power Supply PP–4482/TRD	Power supply

c. Test Fixture.

Equipment	*Fig. reference*
Antenna simulator	7–2
Phase shift network	4–17
Power supply	4–26
Azimuth indicator	7–17
Power panel	7–19
Adapter, receiver	7–8

Section II. TEST PROCEDURES

7–3. Coupler, Antenna CU–1874/TRD–23A

a. Test Equipment Required. Refer to paragraph 7–2 for common names.

Federal stock No.	*Equipment*	*References*
NSN	Attenuator PA–10 (Microlab) or equivalent, 72 ohm, 10 dB, 2 w, 2 kw peak	
NSN	Filter, bandpass (BURNELLNYTRONICS) S–54655 (18–32 MHz)	
NSN	Power combiner DA–3 (Microlab), or equal 50 ohm, 3 arm, 2 w average	
	Radio Interference Measuring Set AN/URM–85	TM 11–6625–351–12
	Voltmeter, Electronic AN/URM–145	TM 11–6625–524–14
6625–868–8353	Generator, Signal AN/GRM–50	TM 11–6625–573–15

b. Test Setup. Connect the equipment as shown in figure 7–1.

c. Gain Test.

(1) Turn on the antenna coupler and (signal generator No. 1).

(2) Adjust the No. 1 signal generator for a frequency of 2.0 MHz and an indication of 0.25 volt on the ac vtvm.

(3) Connect the ac vtvm to the output (J1) of the antenna coupler and read 0.3 volt ±0.05.

(4) Connect the ac vtvm to the output of the power combiner, and adjust the No. 1 signal generator for a frequency of 32 MHz and an indication of 0.25 volt on the rf voltmeter.

(5) Repeat (3) above.

d. Intermodulation Test.

NOTE

If the required test equipment is not available, the adjustments associated with the transistor pair on the repaired assembly should be set to obtain an indication of 50 on the front panel test meter. An indication of 50 on the front panel test meter insures that second order products will be at least 60 db down.

(1) Turn off signal generator No. 1 and turn on signal generator No. 2.

(2) Adjust signal generator No. 2 for a frequency of 7 mc and an indication of 0.25 volts on the ac vtvm.

(3) Turn on both signal generators and tune the receiver to a frequency of 32 mc. Note the db indication on the receiver. This indication is the reference level.

(4) Tune the receiver to a frequency of 25 mc and note the db indication on the receiver. This indication should be at least 70 db down from the reference level in (3) above.

(5) Turn off signal generator No. 2 and adjust signal generator No. 1 for a frequency of 18 mc and a 0.25-volt indication on the ac vtvm.

(6) Turn on signal generator No. 2 and turn off signal generator No. 1. Adjust signal generator No. 2 for a frequency of 8 mc and a 0.25-volt indication on the ac vtvm.

(7) Turn on both signal generators and tune the receiver to a frequency of 18 mc. Note the db indication on the receiver. This indication is the reference level.

(8) Tune the receiver to a frequency of 10 mc and note the db indication on the receiver. This indication should be at least 70 db down from the reference level in (7) above.

(9) Check the front panel meter indication for each position of the LINE METER switch. The indications should be within the limits established in TM 11–5825–231–10.

7–4. Drive, Goniometer-Rotary Coupler TG–126(*)/TRD

a. Test Equipment Required. Refer to paragraph 7–2 for common names.

Federal stock No.	*Equipment*	*References*
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
5950–235–2086	Transformer, Power, Variable CN–16/U	
6625–868–8353	Generator, Signal AN/GRM–50	TM 11–6625–573–15
	Voltmeter, Electronic AN/URM–145	TM 11–6625–524–15
	Amplifier, Control AM–3345/TRD	TM 11–5825–231–25
	Receiver, Radio R–725/URR	TM 11–5825–231–15
	Antenna Simulator SM–447/TRD	TM 11–5825–231–25

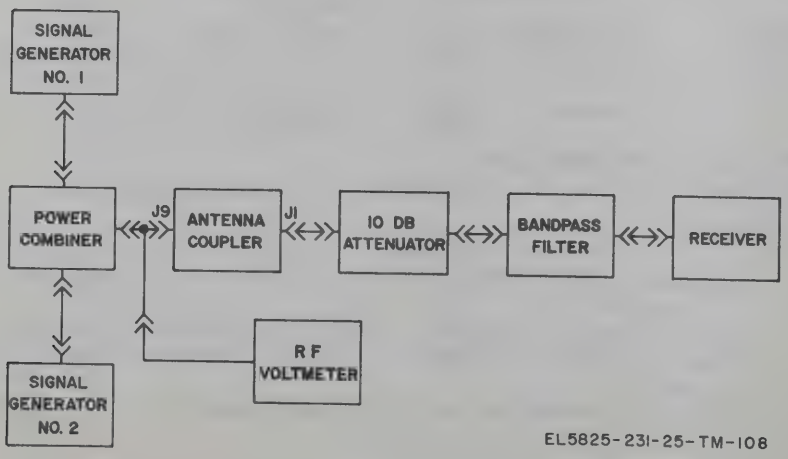


Figure 7–1. Intermodulation test setup, antenna coupler.

b. Test Setup.

(1) Fabricate the test fixture shown in figure 7–2.

Equipment	*Control*
Signal Generator AN/GRM-50	FREQUENCY
	MODULATION
Receiver, Radio R725/URR	FREQUENCY
	AGC
Transformer, Power, Variable CN-16/U	BANDWIDTH
	VOLTAGE

c. Drive Motor Speed.

(1) Turn on the control amplifier and adjust the scope to display two sync pulses.

(2) With the scope probe, measure the 180-Hz drive motor voltage at C3 on the goniometer drive chassis. There should be exactly two cycles of the 180-Hz voltage for every sync pulse.

d. Rotary Coupler—Am./Blending.

(1) Turn on the rf generator and receiver.

(2) Connect the scope probe to the if. output (J116) of the receiver.

(3) Adjust the rf generator for an output level which does not overload the receiver. Use the pattern on the scope as an indicator.

(4) Adjust the scope controls to obtain a trace as shown in figure 7–4. The waveform should have no gaps.

(5) Measure E maximum and E minimum as shown in figure 7–4. Compute the amplitude modulation as follows:

$$\% \text{ AM} = \frac{\text{E max—E min}}{\text{E max—E min}} \times 100$$

The percent am. shall not exceed 6 percent.

e. Sync Pulse Generator.

(1) Disconnect the cables from J2 through J25 on antenna simulator, leaving J1 connected.

(2) Adjust the scope controls to obtain the display shown in figure 7–5. Set the sweep time to 0.5 μsec/cm.

(3) The sync pulse generator orientation is correct when the negative peak of the sync pulse occurs at the peak of the coupling characteristic curve ($\pm$0.2 cm).

(4) Adjust the scope controls to display one sync pulse.

(5) The pulse amplitude should be -0.8 to $+0.2$ volt minimum. The pulse width should be 2.0 milliseconds maximum.

f. Rotary Coupler—Bandpass/Output Isolation.

(1) Turn off the control amplifier, disconnect the receiver, and connect 51-ohm resistors across J26 and J27.

(2) Adjust the rf generator to 10 MHz. Connect the rf millivolt-meter across J26 and

(2) Connect the equipment as shown in figure 7–3.

(3) Set the equipment controls as follows:

Setting
1.5 MHz
CW
1.5 MHz
OFF
2 KHz
Adjust for 115 volts input

align the rotor manually for peak output. Record the reading.

(3) Without moving the rotor, take output readings at 20.0 MHz and 1.5 MHz. These readings should be within $\pm$3 db of the 10–MHz readings.

(4) Without moving the rotor, set the rf generator to 1.5 MHz and note the output level on the millivoltmeter.

(5) Connect the millivoltmeter across J27 and take a reading.

(6) The difference between the two readings is the output isolation, and should be -24 db minimum.

g. Primary Goniometer.

(1) Connect the equipment as shown in figure 7–6.

(2) Set the scope controls as follows:

HORIZ GAIN	0.2 V/CM
VERT GAIN (CHAN 1)	0.2 V/CM
HORIZ DISPLAY	EXT X1
MODE	CHAN 1

(3) Turn on the control amplifier and set the signal generator for 72-kHz, 1-volt output.

(4) Observe a circular display on the oscilloscope. It should be perfectly round.

(5) Orientation is checked by setting the scope controls as follows:

HORIZ DISPLAY	INT
TIME/DIV	0.5 msec/cm
DISPLAY switch	CHOP B TRIGGER

(6) The sync pulse should occur at the peak of the modulation envelope $\pm$0.2 cm.

h. Secondary Goniometer. Repeat procedures for the primary goniometer.

7–5. Amplifier, Electronic Control AM–3345/TRD

a. Test Equipment Required. Refer to paragraph 7–2 for common names.

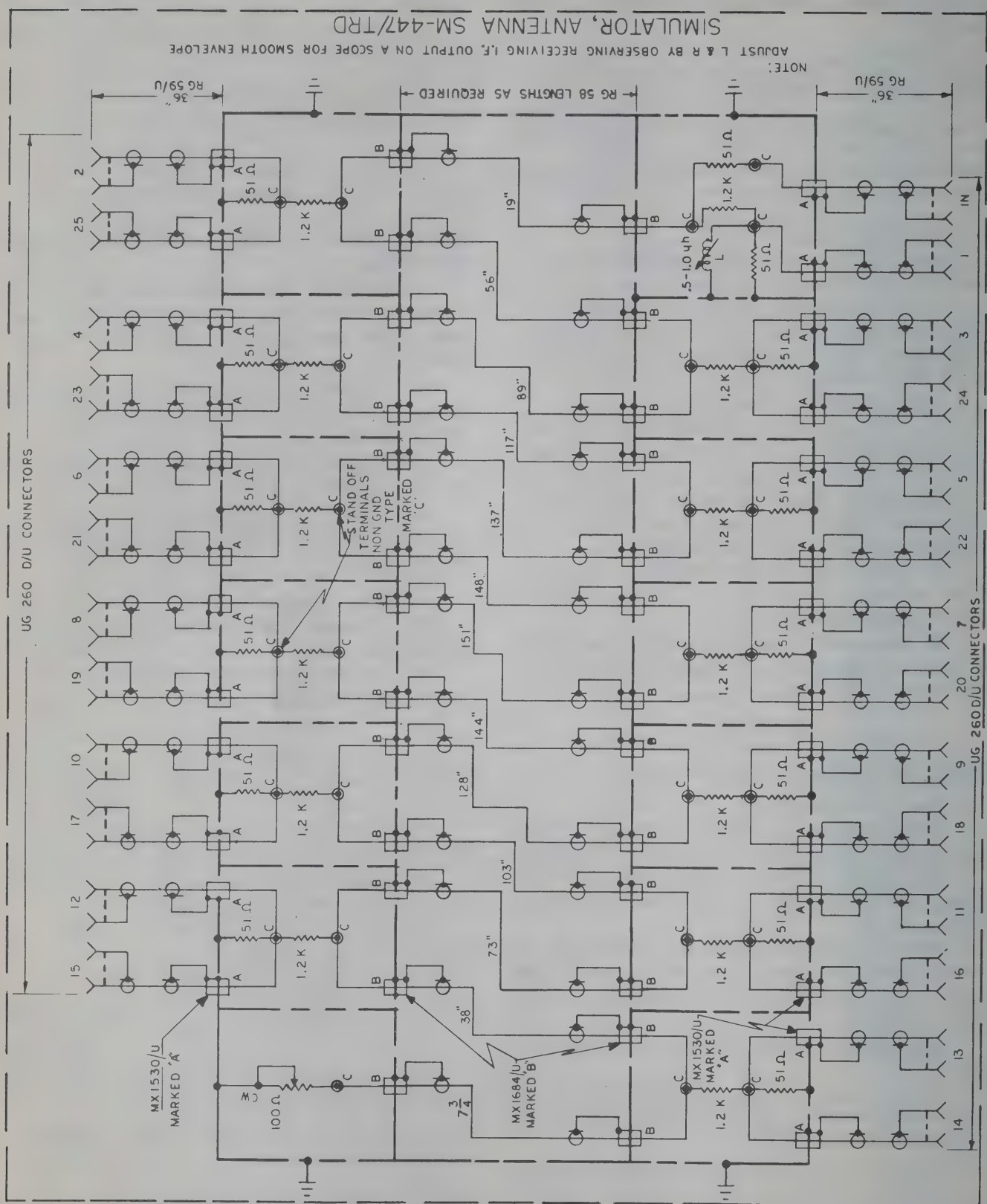


Figure 7-2. Simulator, Antenna SM-447/TRD.

Federal stock No.	*Equipment*	*References*
6625-553-0142	Multimeter TS-352B/U	TM 11-6625-366-15
5950-235-2086	Transformer, Power, Variable CN-16/U	
6625-911-6368	Counter, Electronic Digital Readout AN/URM-207	TM 11-6625-700-10
6625-913-9781	Multimeter ME-26B/U	TM 11-6625-200-15
	Drive, Goniometer-Rotary Coupler TG-126(*)/TRD	TM 11-5825-231-24

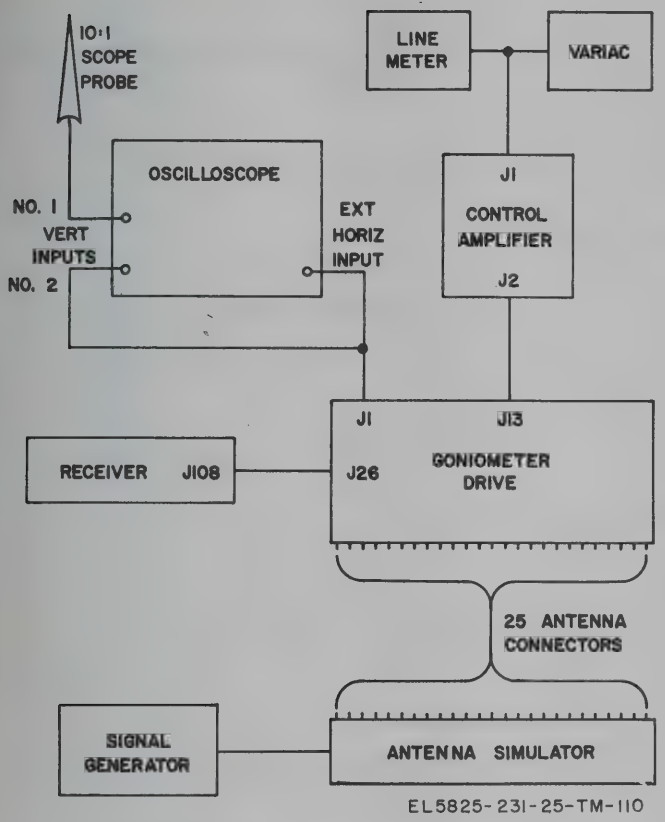


Figure 7-3. Test setup, rotary coupler.

b. Test Setup. Connect the equipment as shown in figure 7-7.

c. Output Frequency.

(1) Turn on the control amplifier and adjust the variac for 115 volts power input.

(2) Measure the period of the output frequency as 5,556.0 micro-seconds ±2.5 on the counter.

d. Output Voltage.

(1) Connect the multimeter across the control amplifier output jacks (J2).

(2) Measure 115 volts ±10 percent.

e. No-Load Test.

(1) Turn off the control amplifier, disconnect the goniometer drive, and turn on the control amplifier again.

(2) With the multimeter, measure the voltage across the output jack (J2) as 0 volt.

7-6. Receiver, Radio R-725/URR

a. Test Equipment Required. Refer to paragraph 7-2 for common names.

Federal stock No.	*Equipment*	*References*
6625-553-0142	Multimeter TS-352B/U	TM 11-6625-366-15
6625-643-1670	Voltmeter, Electronic ME-30B/U	TM 11-6625-320-12
6625-911-6368	Counter, Electronic Digital Readout AN/URM-207	TM 11-6625-700-10
6625-868-8352	Generator, Signal AN/GRM-50	TM 11-6625-573-15
5950-235-2086	Transformer, Power, Variable CN-16/U	
NSN	Attenuator PA-10 (Microlab), or equivalent, 72 ohms, 10 dB, 2w, 2 kw peak	
NSN	Phase angle voltmeter, ADYU Electronics Model 524	Literature packed with the equipment
Locally fabricated (fig. 7-8)	Adapter, transmission line to receiver input	TM 11-5825-231-25
6625-783-5965	Generator, Signal AN/URM-127	TM 11-6625-683-15
6625-913-9781	Multimeter ME-26B/U	TM 11-6625-200-15

b. Test Setup.

(1) Connect the equipment as shown in figures 7-8 and 7-9.

(2) Set the equipment controls as follows:

Equipment	*Control*	*Setting*
Receiver	FUNCTION	AGC
	BFO	OFF
	BANDWIDTH KC	2
	RF GAIN	10
Signal Generator AN/GRM-50	MODULATION	EXT
	FREQUENCY	10 MHz
	OUTPUT	6 mv
Generator Signal AN/URM-127	FREQUENCY	400 Hz
	OUTPUT	Set for 30% modulation on AN/GRM-50

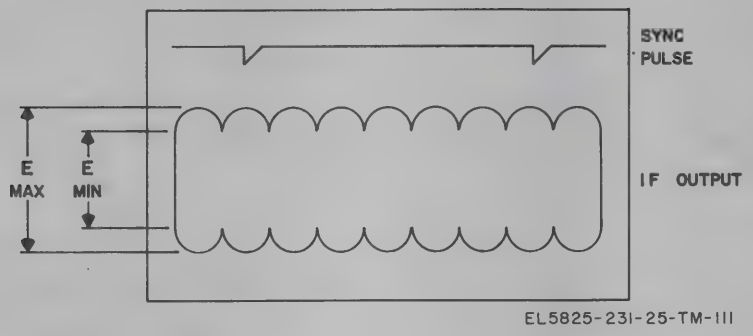


Figure 7-4. Blending amplitude.

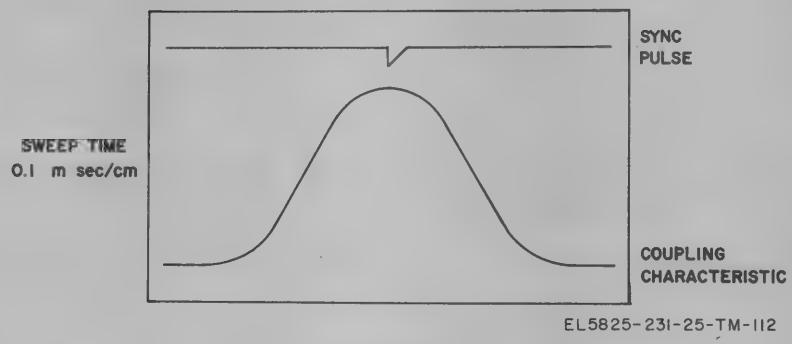


Figure 7-5. Sync pulse orientation.

c. If. Phase Shift (fig. 7-9).

(1) Turn on the receiver and adjust the variac for 115 volts input.

(2) Tune the receiver to the rf generator frequency (10 MHz), and fine tune for an if. output of exactly 455 kHz on the counter. Record the phase angle as read from the phase angle voltmeter.

(3) Retune the receiver for a reading of 455.750 kHz (+750 Hz) on the counter. Record the phase angle voltmeter reading.

(4) Repeat (3) above for a frequency of 454.250 kHz (−750 Hz).

(5) The maximum phase shift between the three readings shall be ±2°.

d. Agc Characteristic (fig. 7-10).

(1) Connect the equipment as shown in figure 7-10.

(2) Set the rf generator for 5 microvolts output, and adjust the receiver LOCAL GAIN control for 5 millivolts on the ME-30C/U.

(3) Increase the rf generator output to 1, 10, and 100 millivolts, noting the db increase in the output level at each step. Compare results with the limits given below.

Input	*Output*
5 μvolt	0 db (reference)
1 mvolt	+ 5 db maximum
100 mvolt	+ 10 db maximum
1,000 mvolt	+ 20 db maximum

e. Sensitivity (fig. 7-10).

(1) Set the equipment controls as follows:

Equipment	*Control*	*Setting*
Signal generator	FREQUENCY	1.0 MHz
	OUTPUT	10.0 μvolts
Receiver	BANDWIDTH KC	8
	FUNCTION	MGC
	LOCAL GAIN	10

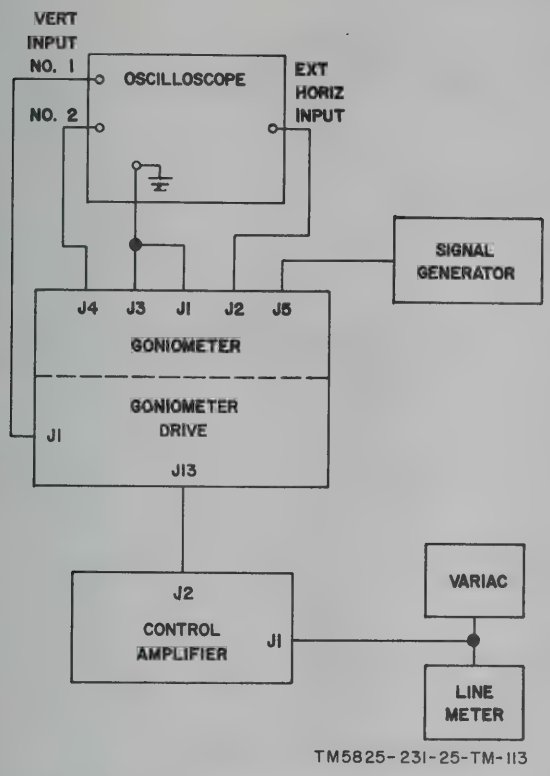


Figure 7–6. Test setup, goniometer.

(2) Adjust the receiver KILOCYCLE CHANGE and ANT TRIM controls for a maximum indication on the ac vtvm.

(3) Adjust the receiver LOCAL GAIN control for a db reference on the ac vtvm (approximately 10 MV).

(4) Reduce the rf generator level to 3.3 μv. Readjust the LOCAL GAIN control as necessary to maintain the db reference on the ac vtvm.

(5) Set the rf generator MODULATION switch to CW. Read the new db level as measured on the ac vtvm and subtract this reading from the db reference of (3) above.

(6) This difference shall exceed 10 db.

(7) Repeat (2) through (6) above at a frequency of 20.0 MHz and a signal level of 4.4 μv.

f. Overall gain and If. (fig. 7–11).

(1) Connect the equipment as shown in figure 7–11.

(2) Set the equipment controls as follows:

Equipment	*Control*	*Setting*
Signal generator	FREQUENCY	4.0 MHz
	MODULATION	CW
Receiver	BANDWIDTH KC	8

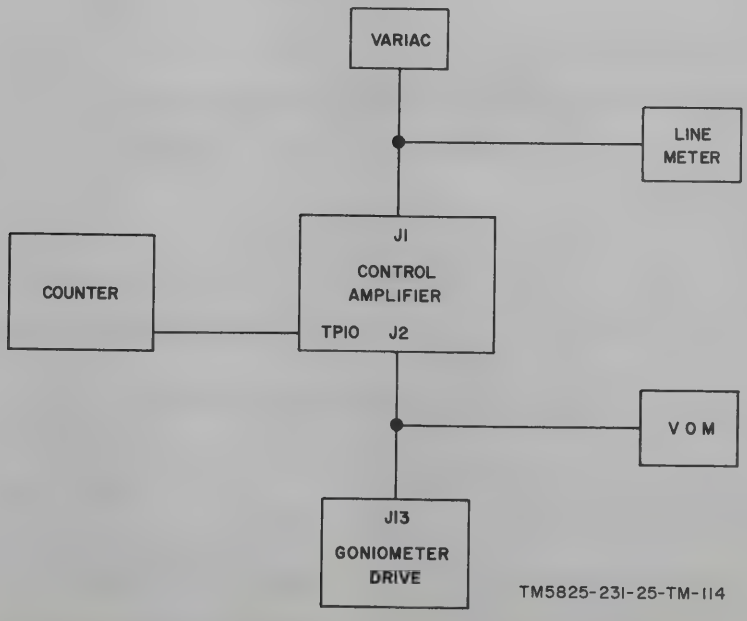


Figure 7–7. Test setup, control amplifier.

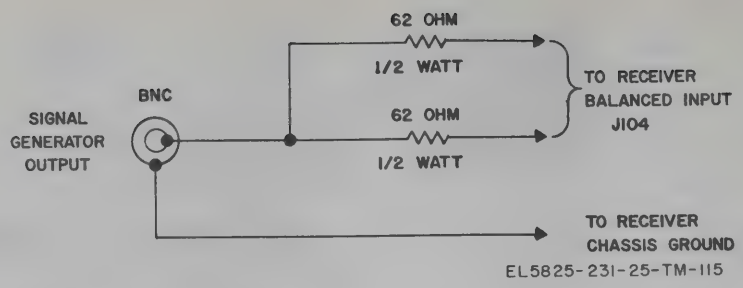


Figure 7–8. Adapter, 50 to 125 ohms.

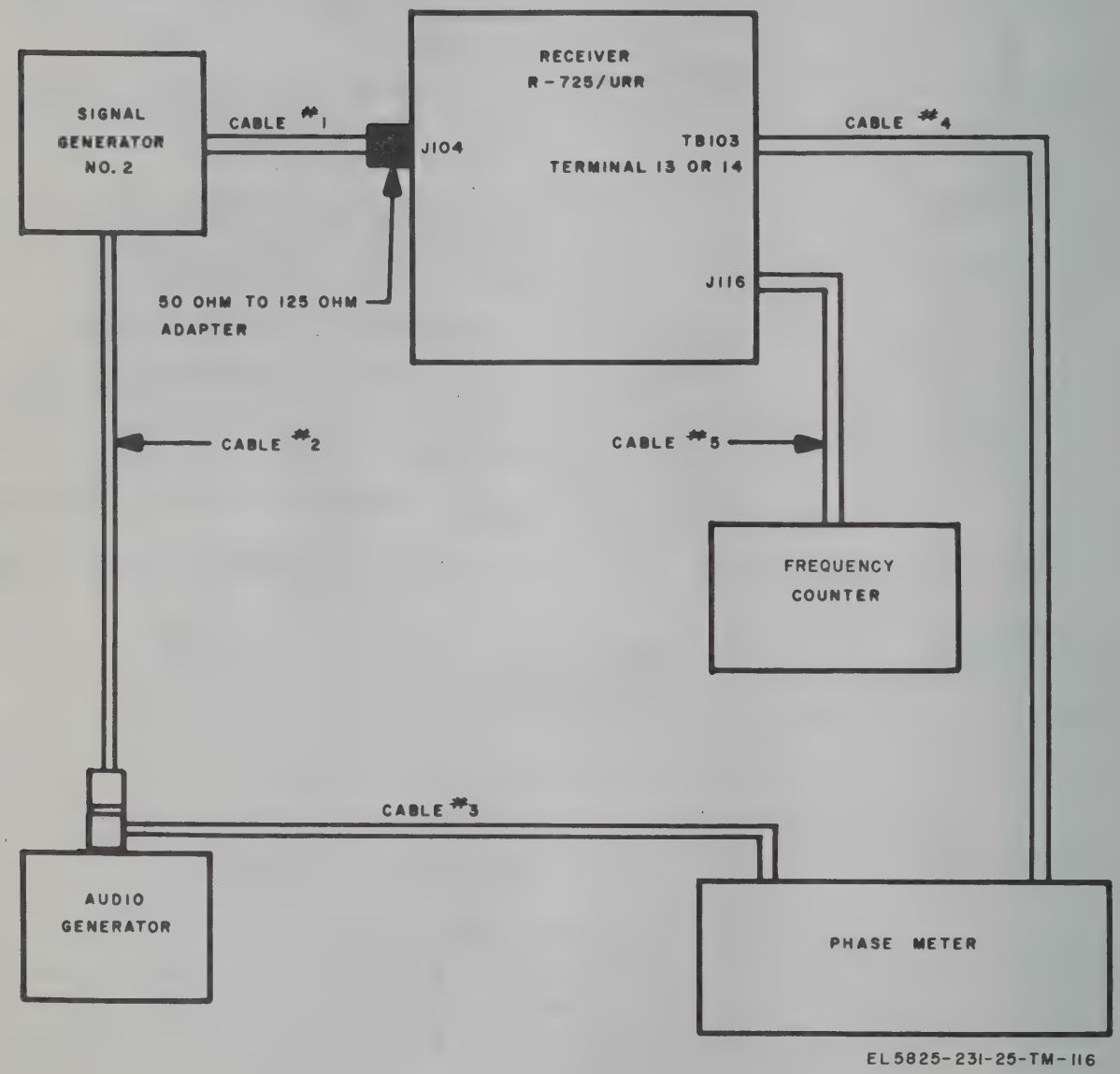


Figure 7–9. Test setup, if. phase shift.

(3) Tune the receiver for maximum output.

(4) Measure the if. on the counter as 455 kHz ±0.3.

(5) Adjust the signal generator output for a reading of 7.0 volts on the dc vtvm.

(6) The signal input should not exceed 4.0 uvolts.

(7) Repeat (1) through (5) above at a frequency of 16 MHz.

g. Selectivity (fig. 7–12).

(1) Connect the equipment as shown in figure 7–12.

(2) Set the equipment controls as follows:

Equipment	*Control*	*Setting*
Signal generator	FREQUENCY	1.0 MHz
	OUTPUT	100 uvolts
	MODULATION	CW
Receiver	BANDWIDTH KC	1
	BFO	OFF
	FUNCTION	AGC
	RF GAIN	10

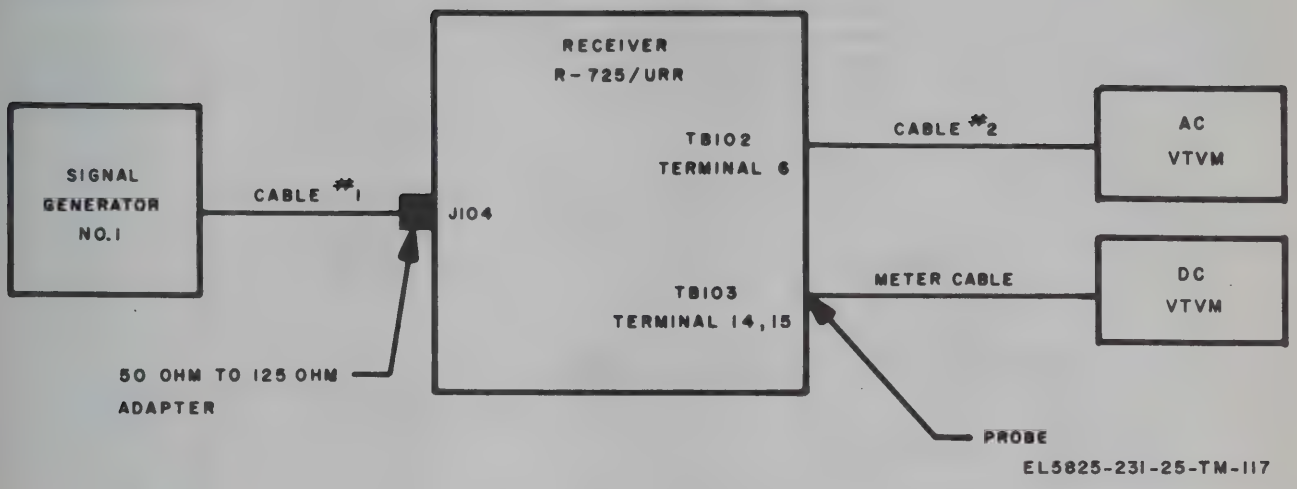


Figure 7–10. Test setup, agc and sensitivity.

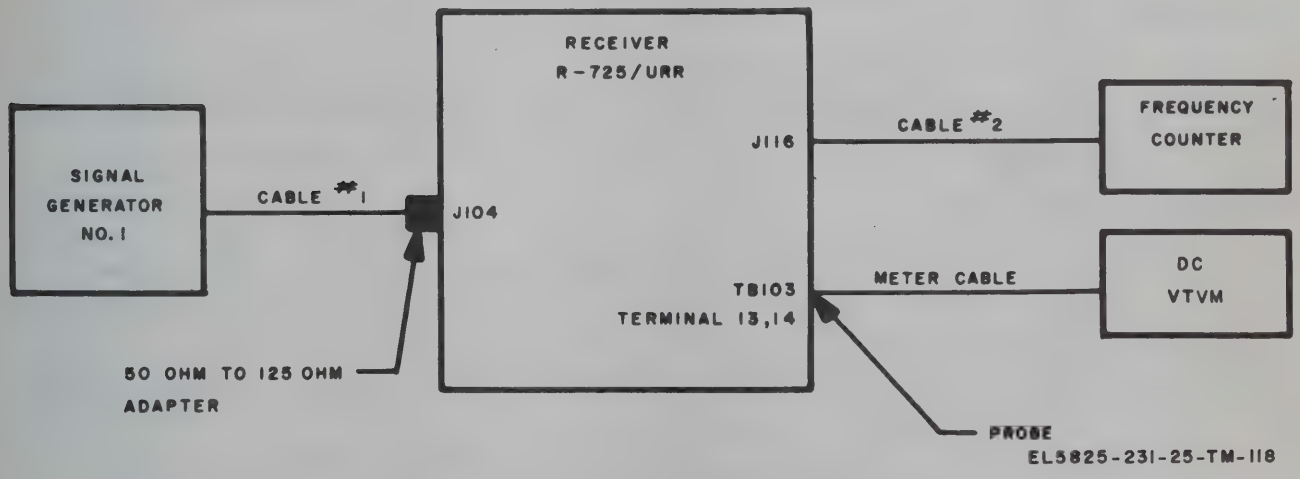


Figure 7–11. Test setup, gain and if..

(3) Tune the receiver for maximum output on the ac vtvm.

(4) Retune the rf generator on the low side of the original frequency setting until the reading on the ac vtvm decreases by 6.0 db. Record the new frequency as read on the counter.

(5) Repeat (4) above, tuning the rf generator on the high side of the original frequency.

(6) Repeat (3) through (5) above with the receiver BANDWIDTH KC switch set to 1, 2, 4, 8, and 16.

(7) Tolerances for the high- and low-frequency spread are given below:

BANDWIDTH KC pos	*KILOCYCLE CHANGE readings*
0.1	0.10 to 0.18
1	0.9 to 1.5
2	1.7 to 2.5
4	3.2 to 4.6
8	11.5 max
16	17.0 max

7–7. Detector, Radiofrequency RF–159(*)/TRD

a. Test Equipment Required. Refer to paragraph 7–2 for common names.

Federal stock No.	*Equipment*	*References*
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–6625–320–12
6625–783–5965	Generator, Signal AN/URM–127	TM 11–6625–683–15
6625–911–6368	Counter, Electronic Digital Readout AN/URM–207	TM 11–6625–700–10
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
6625–868–8353	Generator, Signal AN/GRM–50	TM 11–6625–573–15
5950–235–2086	Transformer, Power, Variable CN–16/U	
6625–868–8352	Generator, Signal AN/URM–103	TM 11–6625–586–12
5820–069–8915	Receiver, Radio R–725/URR	TM 11–5825–231–25
Locally fabricated (fig. 4–17)	Phase-shift network	TM 11–5825–231–25

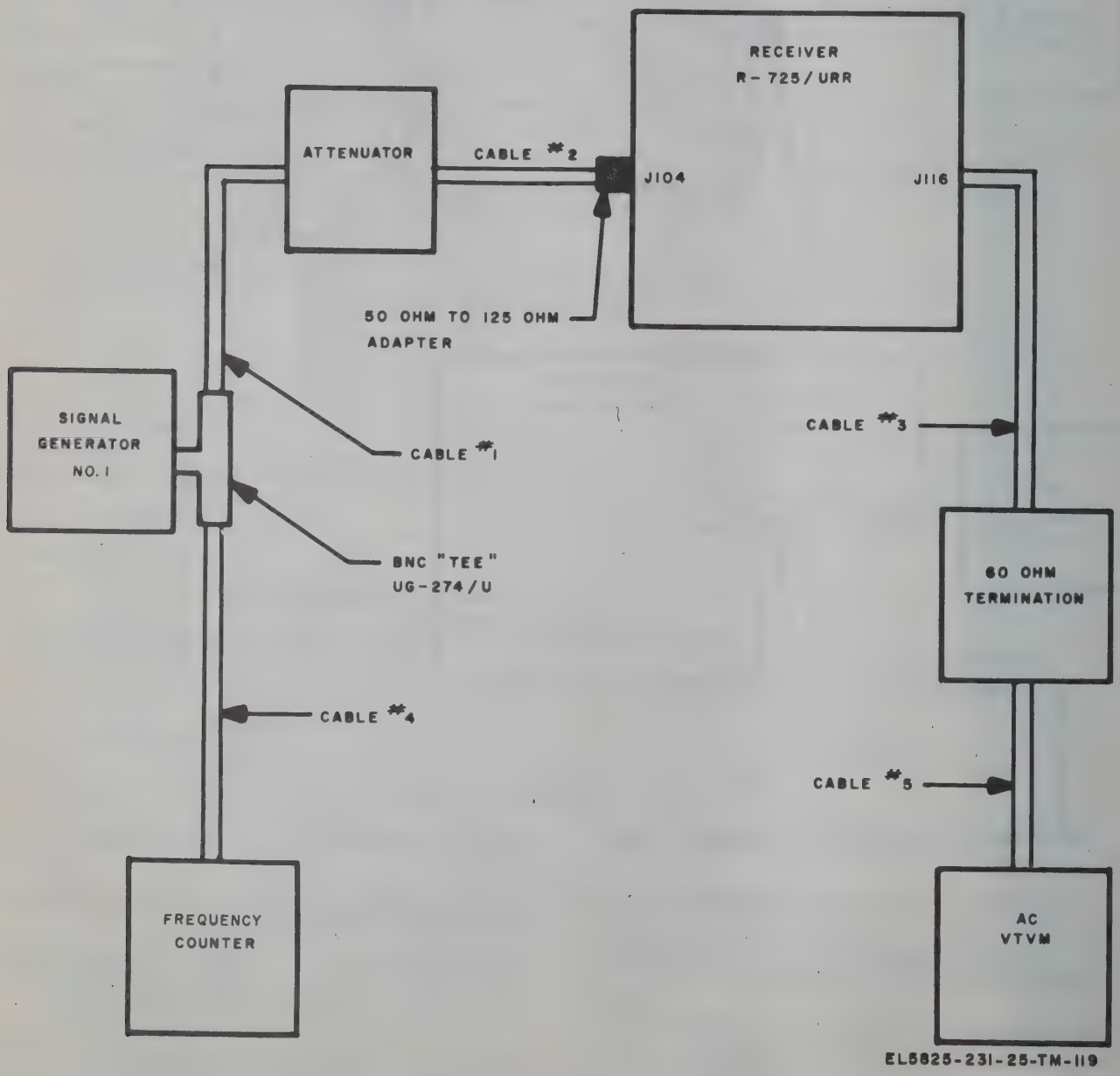


Figure 7–12. Test setup, selectivity.

b. Test Setup.

(1) Connect the equipment as shown in figure 7–13.

(2) Set the equipment controls as follows:

Equipment	*Control*	*Setting*
Audio signal generator	FREQUENCY	1 KHz
	OUTPUT	1 volt
Rf generator	FREQUENCY	455 KHz
	MODULATION	1000 Hz, 30%
	OUTPUT	100 μvolts

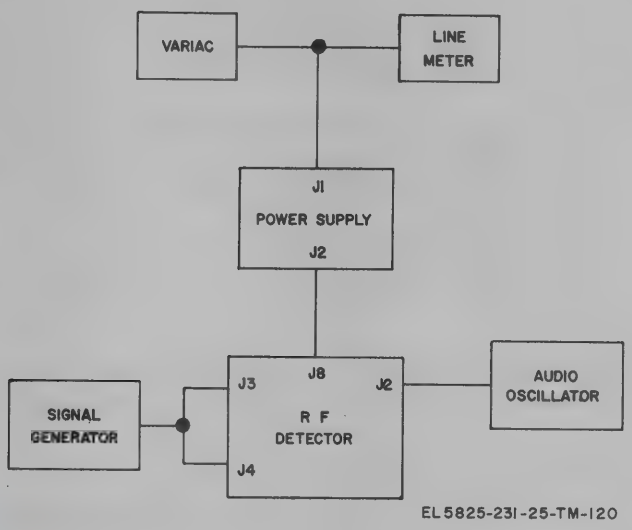


Figure 7–13. Test setup, rf detector.

c. Loudspeaker Check.

(1) Turn on the audio signal generator.

(2) Note a moderately loud clear tone from the loudspeaker.

d. Local Oscillator Output.

(1) Turn on the power supply and adjust the line voltage to 115 volts with the variac.

(2) With the counter and ac vtvm, observe a 455-kHz ±0.3 kHz, 1.0- to 8.0-volt signal at TP1 (fig. FO–6).

(3) Insert the jumper wire between pins A and B of J1. (Relay K1 operates.) Note the disappearance of the 455-kHz signal observed in (2) above. Leave the jumper connected (fig. FO–6).

e. Am. Limiting.

(1) Turn on the rf generator.

(2) Remove crystals Y2 and Y3 (fig. FO–6).

(3) With the scope probe, observe the limiter chain outputs at TP3 and TP7.

(4) The amount of amplitude variation between signals at two test points must not exceed 2 percent.

f. Limiter Dynamic Range.

(1) Set the rf generator MODULATION switch to CW and increase the output to 500 uvolts.

(2) Note the output levels at TP3 and TP7 using the ac vtvm. They should be 17.5 volts ±2.5.

(3) Reduce the input to 2 μvolts and recheck the output levels at TP3 and TP7. They should be within ±0.2 volts of the levels observed in (2) above.

g. Mixer Output.

(1) Replace crystals Y2 and Y3 in their sockets.

(2) Set the rf generator output to 200 μvolts.

(3) With the ac vtvm, measure the 5-kHz signal at TP9 as 1.1 volts ±0.9 (fig. FO–7).

(4) Remove the jumper from J1 and disconnect the test equipment.

h. Phase Shift and Distortions.

(1) Connect the rf detector as shown in figure 7–14.

(2) Set the controls as follows:

Equipment	*Control*	*Setting*
Audio Oscillator AN/URM–127	FREQUENCY control	90 Hz
	OUTPUT control	Set for indication of 1.0 on panel meter.
	FREQ. RANGE MULTIPLIER	X1
	ATTENUATOR	X100
Oscilloscope AN/USM–281	Horizontal DISPLAY switch	EXT SENS
	Horizontal amplifier external input coupling switch (AC DC)	AC
	Channel A input coupling switch (AC GND DC)	AC
	Channel A VOLTS/DIV control	Adjust for correct pattern
	Channel A VOLTS/DIV switch	50 mv/DIV
	Vertical DISPLAY switch	A
	Channel A POLARITY switch	+ UP
Signal Generator AN/URM–103	BAND SWITCH	Band A 18 28 MEGAHERTZ
	LO-HI RF SET TO LINE control	Adjust to set meter pointer to line
	FUNCTION switch	EXT MOD
	DEVIATION RANGE KHZ control	10
	LO RF UV control	100 uv
	RF OUTPUT switch	LO 0 10 UV
	DEVIATION control	Set to get stable pattern

(3) Adjust the oscilloscope controls and the phase shift network to obtain the pattern shown in figure 7–15.

(4) A single straight line pattern should be displayed with less than 0.5 cm deviation from the three points marked.

Note. Improper control settings on the test equipment may result in false indications in the above test. Avoid excessive output levels into the radio receiver.

7–8. Power Supply PP–4482/TRD

a. Test Equipment Required.

Federal stock No.	*Equipment*	*References*
6625–553–0142	Multimeter TS–352B/U	TM 11–6625–366–15
5950–235–2086	Transformer, Power, Variable CN–16/U	
6625–228–2201	Oscilloscope AN/USM–281A	TM 11–6625–1703–15
Locally fabricated (fig. 4–26)	Test fixture	TM 11–5825–231–25

b. Test Setup. Connect the equipment as shown in figure 4–25. Details of the test fixture are shown in figure 4–26.

c. B+ Voltage and Regulation.

(1) Turn on the control amplifier, and adjust the line voltage to 115 volts with the variac.

(2) On the test fixture, set the FILAMENT LOAD switch to ON and the B+ LOAD switch to LIGHT.

(3) With the multimeter, measure the B+ output voltage at test points C and D on the test fixture as 250 volts ±2.0.

(4) Set the B+ LOAD switch to HEAVY and repeat (3) above.

(5) Reset the B+ LOAD switch to LIGHT.

d. Hum and Noise. With the oscilloscope, measure the peak-to-peak hum and noise at test points C and D on the test fixture as 0.25 volt maximum.

e. Filament Voltage.

(1) With the multimeter, measure the filament voltage across test points A and B on the test fixture as 6.1 volts ±0.4.

(2) Set the FILAMENT LOAD switch to OFF, and measure the filament voltage across test points A and B as 6.3 volts ±0.3.

7–9. Indicator, Azimuth IP–669/TRD

a. Test Equipment Required.

Federal stock No.	*Equipment*	*References*
5950–235–2086	Transformer, Power, Variable CN–16/U	TM 11–6625–366–15
6625–553–0142	Multimeter TS–352B/U	TM 11–5825–231–25
	Amplifier, Control AM–3345/TRD	TM 11–6625–320–12
6625–643–1670	Voltmeter, Electronic ME–30B/U	TM 11–5825–231–25
Locally fabricated (fig. 7–17)	Test fixture	

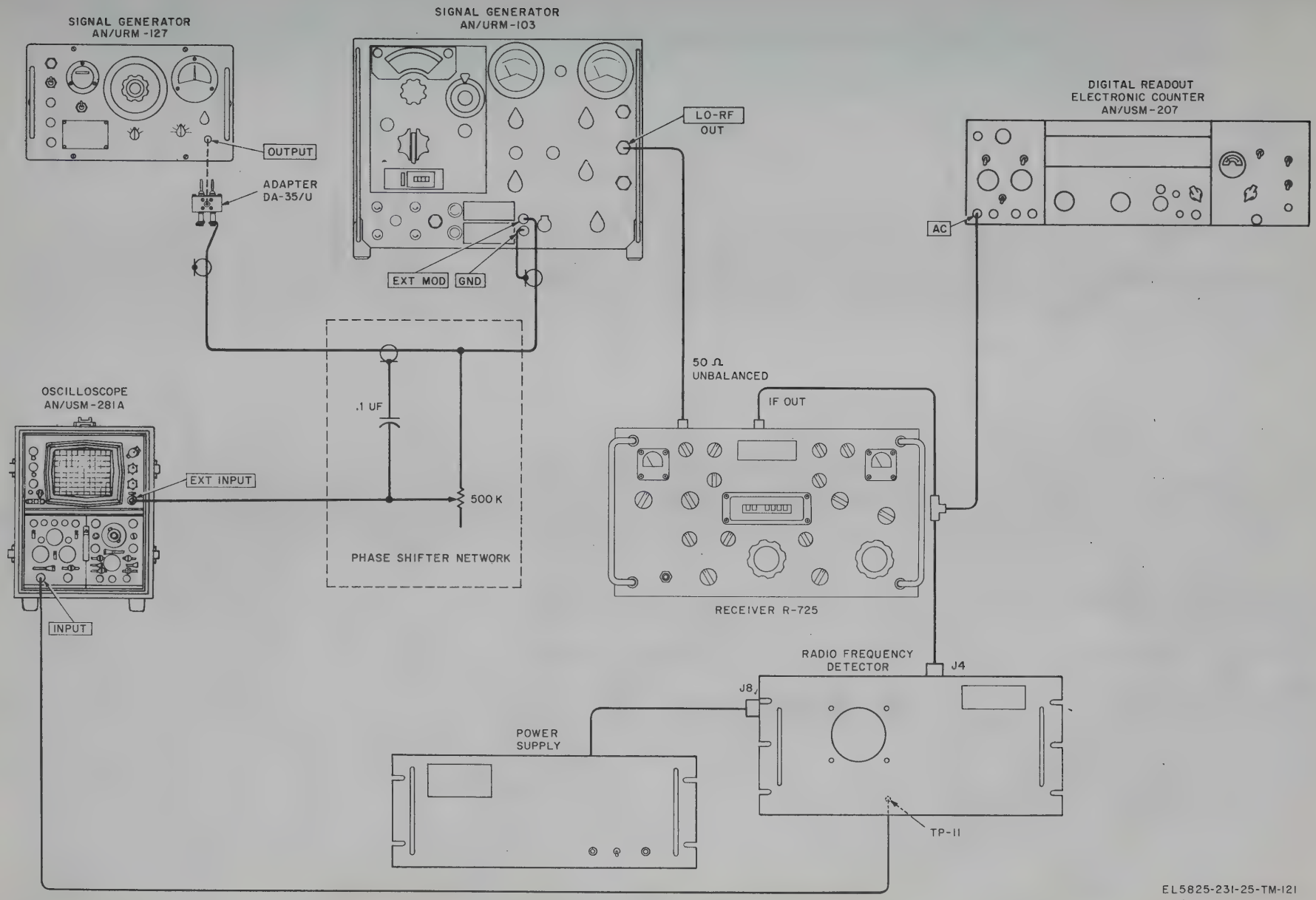


Figure 7–14. Test setup, rf detector distortion.

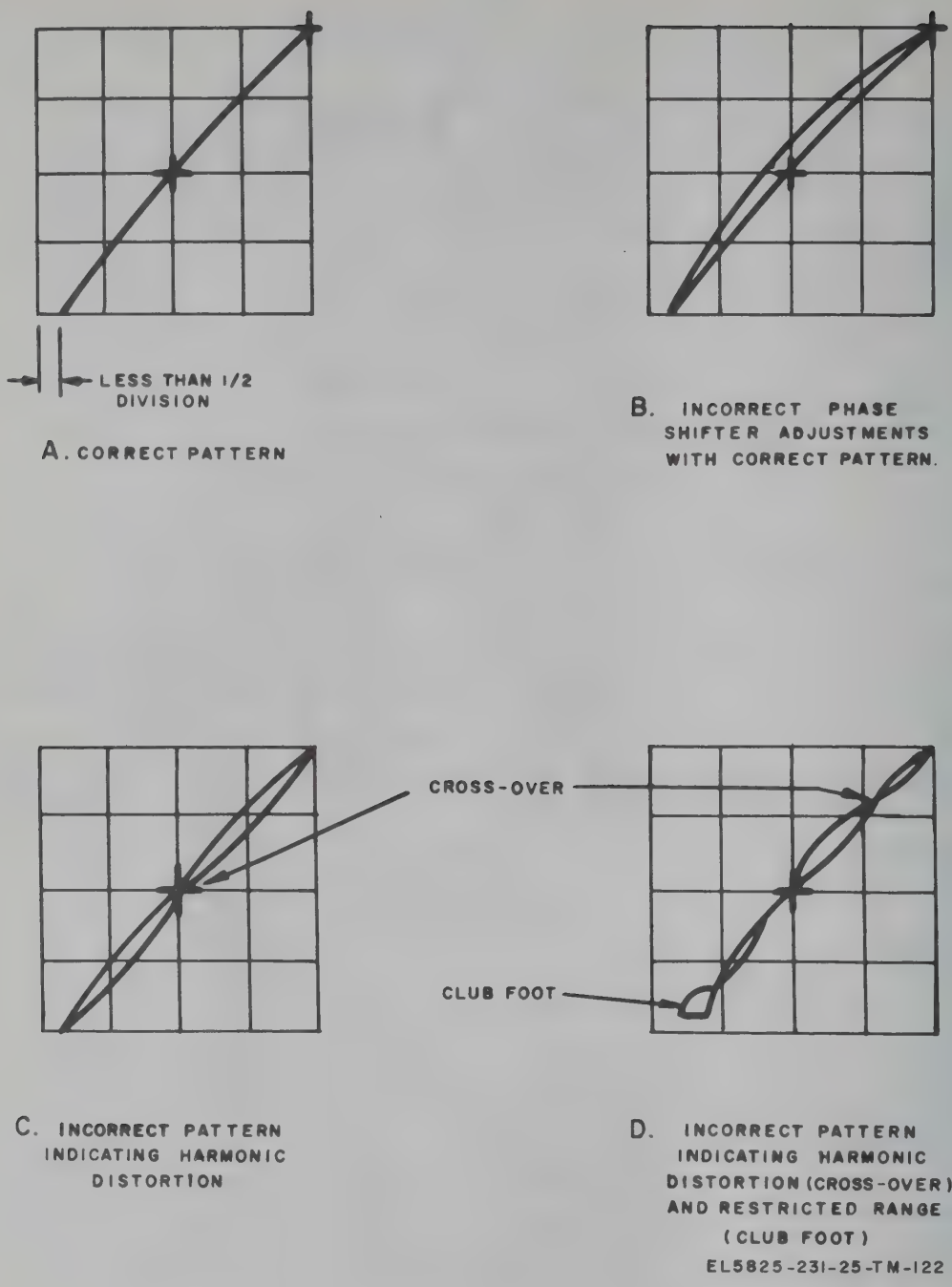

LESS THAN 1/2 DIVISION
A. CORRECT PATTERN
B. INCORRECT PHASE SHIFTER ADJUSTMENTS WITH CORRECT PATTERN.
CROSS-OVER
CLUB FOOT
C. INCORRECT PATTERN INDICATING HARMONIC DISTORTION
D. INCORRECT PATTERN INDICATING HARMONIC DISTORTION (CROSS-OVER) AND RESTRICTED RANGE (CLUB FOOT)
EL5825-231-25-TM-122

Figure 7–15. Oscilloscope waveforms, distortion test.

b. Test Setup.

(1) Connect the equipment as shown in figure 7–16.

(2) Set the equipment controls as follows:

Equipment	*Control*	*Setting*
Azimuth indicator	INTENSITY	Fully ccw
	DIMMER	Fully ccw
	D.F. GAIN	Fully ccw
	SIZE	Fully ccw

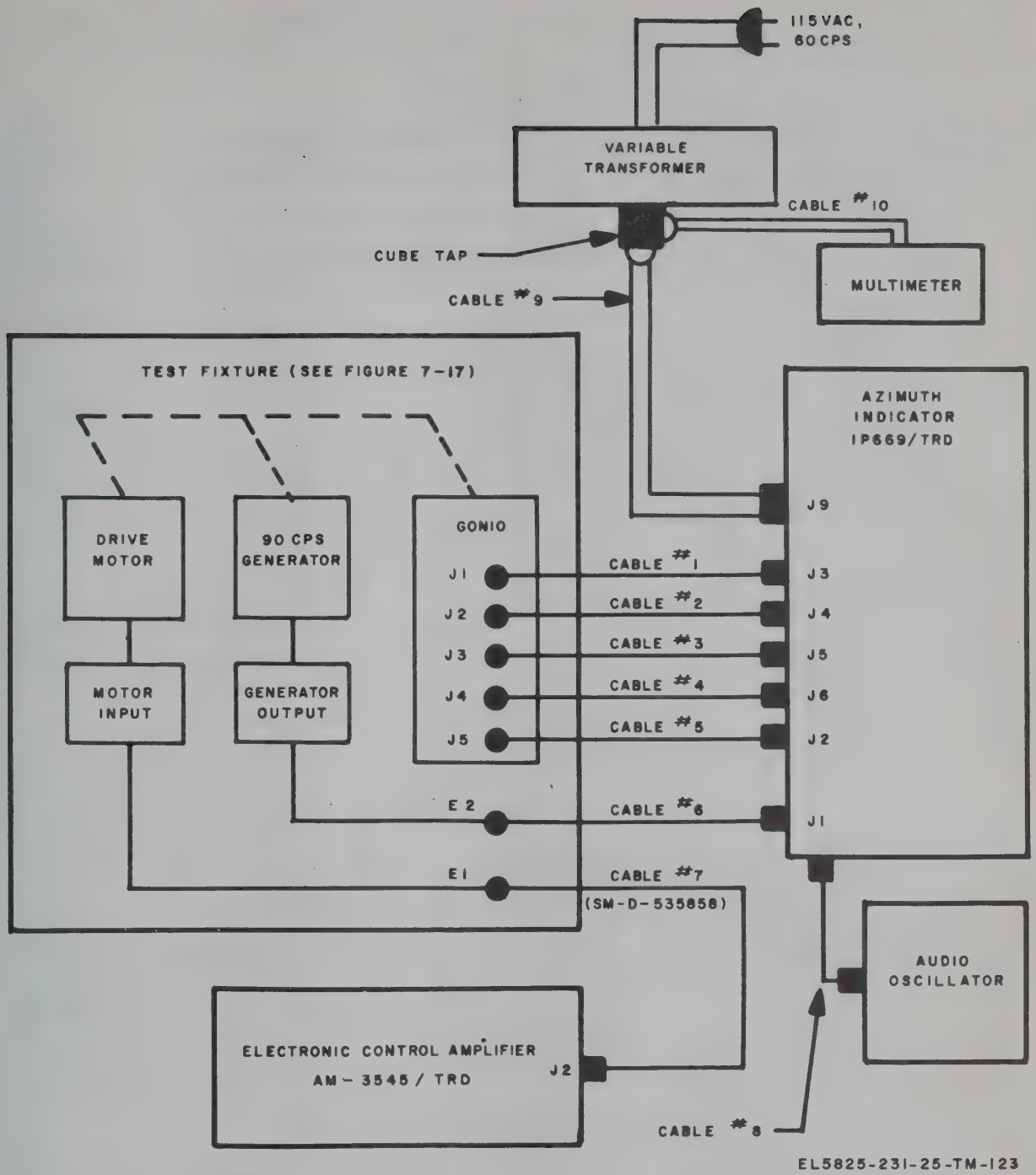


Figure 7-16. Test setup, azimuth indicator.

c. Alidade Assembly.

(1) Turn on azimuth indicator and adjust line voltage to 115 volts with the variac.

(2) Slowly rotate DIMMER control fully clockwise.

(3) The azimuth scale lighting shall gradually increase from low illumination to full illumination. All numerals and degree graduations shall be readily discernible. There shall be no *hot spots* of illumination on either the alidade scale or the face of the crt.

(4) Manually rotate alidade crosshairs. The assembly shall move freely through an angular rotation at least 120°.

d. Circular Pattern.

(1) Adjust azimuth indicator INTENSITY, FOCUS, HORIZONTAL, and VERTICAL controls to obtain a sharp dot centered on the crt face.

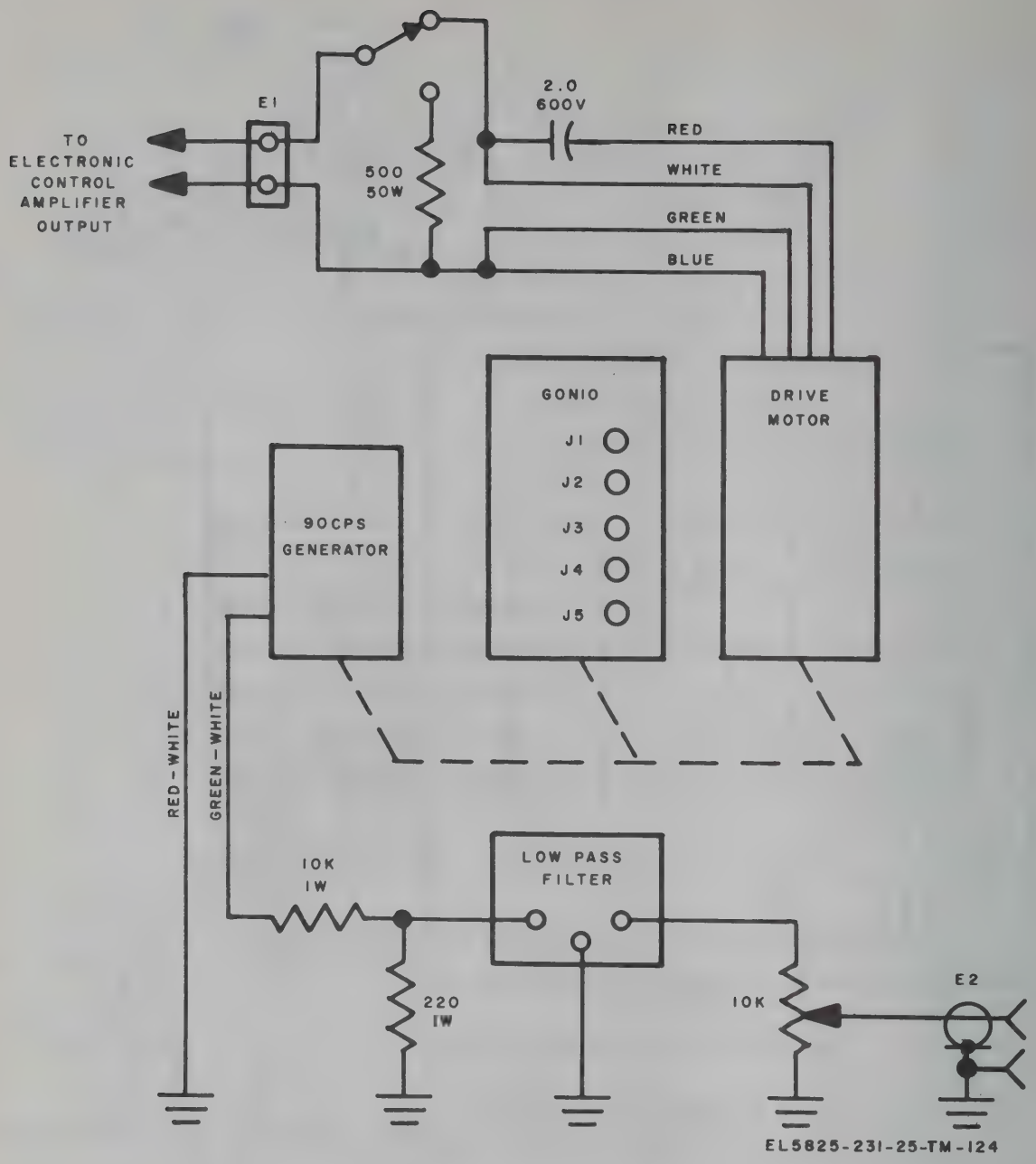


Figure 7–17. Test fixture, azimuth indicator.

(2) Turn on the control amplifier.

(3) Adjust the SIZE and SHAPE controls to produce a full scale circular pattern.

(4) The pattern shall be free of distortion, and the center star shall not exceed 1/16 inch.

e. Sensitivity.

(1) Set the azimuth indicator D.F. GAIN control fully cw.

(2) Increase the output of the 90-cycle generator until the center of the propeller pattern is fully closed.

(3) Measure the output of the 90-cycle generator with the ac vtvm as 3.0 volts maximum.

(4) The propeller is well defined and free of splits.

f. Bearing Accuracy.

(1) Rotate the 90-cycle generator frame to align the test fixture azimuth scale at 0°.

(2) Adjust the goniometer to give 0° indication on the azimuth indicator.

(3) Rotate the 90-cycle generator in 30° increments through 360°.

(4) At each step, check the display on the azimuth indicator. The bearing accuracy of the display should be within ±1.5°.

7-10. Panel, Power Distribution SB-1747/TRD

a. Test Equipment Required. Refer to paragraph 7-2 for common names.

Federal stock No.	*Equipment*	*References*
6625-553-0142	Multimeter TS-352B/U	TM 11-6625-366-15
Locally fabricated (fig. 7-19)	Test fixture	TM 11-5825-231-25

b. Test Setup.

(1) Connect the equipment as shown in figure 7-18.

(2) Set the equipment controls as follows:

Equipment	*Control*	*Setting*
Power panel	LINE INPUT	OFF
	LOAD	OFF
	OUTPUT VOLTAGE CONTROL	6
Test fixture	ON-OFF	OFF
	LOAD	LIGHT

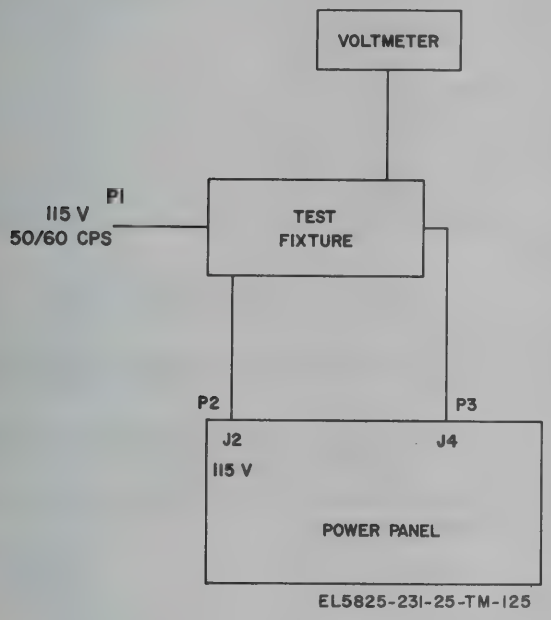


Figure 7-18. Test setup, power panel.

c. Meter Check.

(1) Set the LINE INPUT switch to 115 VAC.

(2) Connect the multimeter to E1 and E2 on the test fixture, and measure the line voltage.

(3) The voltage as read on the power panel OUTPUT VOLTAGE meter should be the same as the voltage measured in (2) above ±3 volts.

(4) The power panel LINE FREQUENCY meter should indicate 60 Hz.

d. Output Voltage.

(1) Connect the multimeter to E3 and E4 on the test fixture and set the power panel output LOAD switch to ON.

(2) Rotate the power panel OUTPUT VOLTAGE CONTROL switch through all positions. The output voltage should vary between 105 and 125 volts.

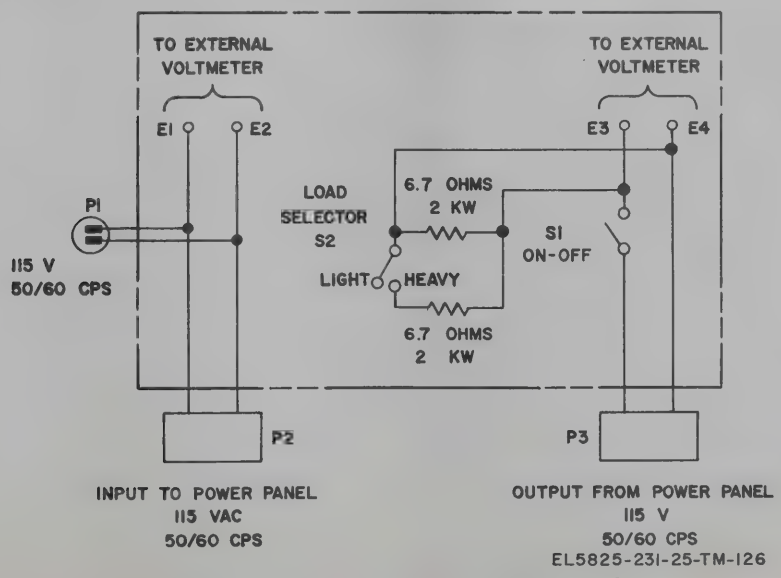


Figure 7-19. Test fixture, power panel.

e. Overload.

(1) Reset the power panel OUTPUT VOLTAGE CONTROL switch to 6.

(2) Set the test fixture LOAD switch to HEAVY.

(3) The circuit breaker should trip within 18 seconds ±12.

7-11. Transmitter, Radio T-279A/UR

a. Test Equipment Required.

Federal stock No.	*Equipment*	*References*
6625-911-6368	Readout Electronic Counter Digital AN/URM-207	TM 11-6625-700-10
6625-228-2201	Oscilloscope AN/USM-281A	TM 11-6625-1703-15
6625-553-0142	Multimeter TS-352B/U	TM 11-6625-366-15
	Resistor, 2,200-ohm, ½-watt Voltmeter, Electronic AN/URM-145	TM 11-6625-524-14

b. Test Setup.

(1) Remove the unit from its case.

(2) Connect the dummy load between chassis ground and one of the antenna contactor clips.

(3) Collapse the antenna fully.

(4) Set the transmitter controls as follows:

Control	*Setting*
BANDSWITCH	16-30mc
CW-MCW	CW
OUTPUT	Fully clockwise
TRANSMITTER	OFF

c. Frequency Drift.

(1) Connect the counter between the antenna and the chassis.

(2) Set the transmitter dial to 25 MHz.

(3) Turn the TRANSMITTER switch to ON, and allow 10 minutes for the unit to stabilize.

(4) Record the frequency reading on the counter.

(5) After an additional 15 minutes of operation, recheck the frequency reading on the counter. The difference between the two readings should not exceed 5 kHz.

(6) The counter should indicate 25 MHz ±1 percent.

d. Indicator Light.

(1) Connect the counter across the indicator lamp terminals and measure the pulse rate.

(2) The pulse rate of the indicator lamp should be 40 ppm ±20.

e. Carrier Tick.

(1) Connect the scope probe to the antenna and set the sweep for 2 μsec/cm.

(2) Examine the carrier for blanking when the indicator lamp flashes.

f. Modulation.

(1) Set the transmitter CW-MCW switch to MCW.

(2) Adjust the scope sweep for 0.5 μsec/cm and observe the time (cm) between modulation pulses.

(3) This time shall be 2.2 μsec ±0.8.

g. Output.

(1) Connect the field strength meter to the antenna.

(2) Measure the output voltage across each frequency band of the transmitter.

(3) The output voltage shall exceed the values listed as follows:

Band	*Voltage*
.5-1.0	25
1.0-2.0	25
2.0-4.0	22
4.0-8.0	20
8.0-16.0	14
16.0-32.0	7

CHAPTER 8

TIME BASE PLUG-IN UNIT MODEL 1820A

Section I. INTRODUCTION

8-1. General

Test Oscilloscope AN/USM-318(V)1 is comparable to Oscilloscope AN/USM-281A, except that a different time base plug-in unit is used and the 19-inch rack-mounted frame is used. The vertical amplifier plug-in on the AN/USM-281A does not have front panel probe power connectors. Refer to TM 11-6625-1703-15 for instructons on maintenance of the oscilloscope frame circuits and on the vertical amplifier plug-in unit. This chapter will provide maintenance instructions for time base (horizontal) plug-in unit HP-1820A.

8-2. Description

The HP-1820A time base plug-in unit (fig. 8-1) is a linear sweep generating plug-in unit for the AN/USM-318(V)1 or the AN/USM-281A. Twenty-four ranges provide calibrated sweep speeds from 0.05 μsec/cm to 2 sec/cm in a 1, 2, 5 sequence. The slowest sweep range can be extended beyond 5 sec/cm and sweep speeds in between ranges can be continuously varied by means of a vernier. The fastest sweep range can be expanded to 5 nsec/cm by the horizontal amplifier on the AN/USM-318(V)1. The sweep can be triggered by an internal signal from the vertical plug-in or by an external signal from dc to 90-MHz. Front panel controls allow triggering slope, level, coupling, holdoff time, and sweep speed selection. By operating in automatic, a bright baseline is present even in the absence of a trigger. Transient waveform photography is possible by using single sweep operation. Variable holdoff allows stable viewing of repetitive complex waveforms.

8-3. Technical Characteristics

Range	0.05 μsec/cm to 2 sec/cm in 24 ranges with vernier control between 1, 2, and 5 sequence.
Triggering:	
Normal:	
Internal	See TM 11-6625-1703-15 for vertical plug-in data.
External	0.5 v peak to peak from dc to 50 MHz, increasing to 1 v peak-to-peak at 90 MHz.
Line	Powerline waveform is used for triggering.
Slope	Selectable, positive or negative.
Trigger point	Adjustable ±5 v over selected trigger signal; ±50 v in EXT −10.
Trigger coupling	Dc, ac, acf, acs; ac attenuates signals below approximately 20 Hz; acf below 15 kHz; acs attenuates signals above approximately 30 kHz.
Automatic	Bright baseline displayed in absence of trigger signal. Triggering is same as normal, except lower frequency limit of signal is 40 Hz.
Variable holdoff	Permits stable display of repetitive-complex waveforms.
Single sweep	Front panel controls permit single sweep operation.
Weight	Net, 2¾ lb (1.3 kg); shipping, 5¼ lb (2.4 kg).

Figure 8-1. Time base, 1820A.

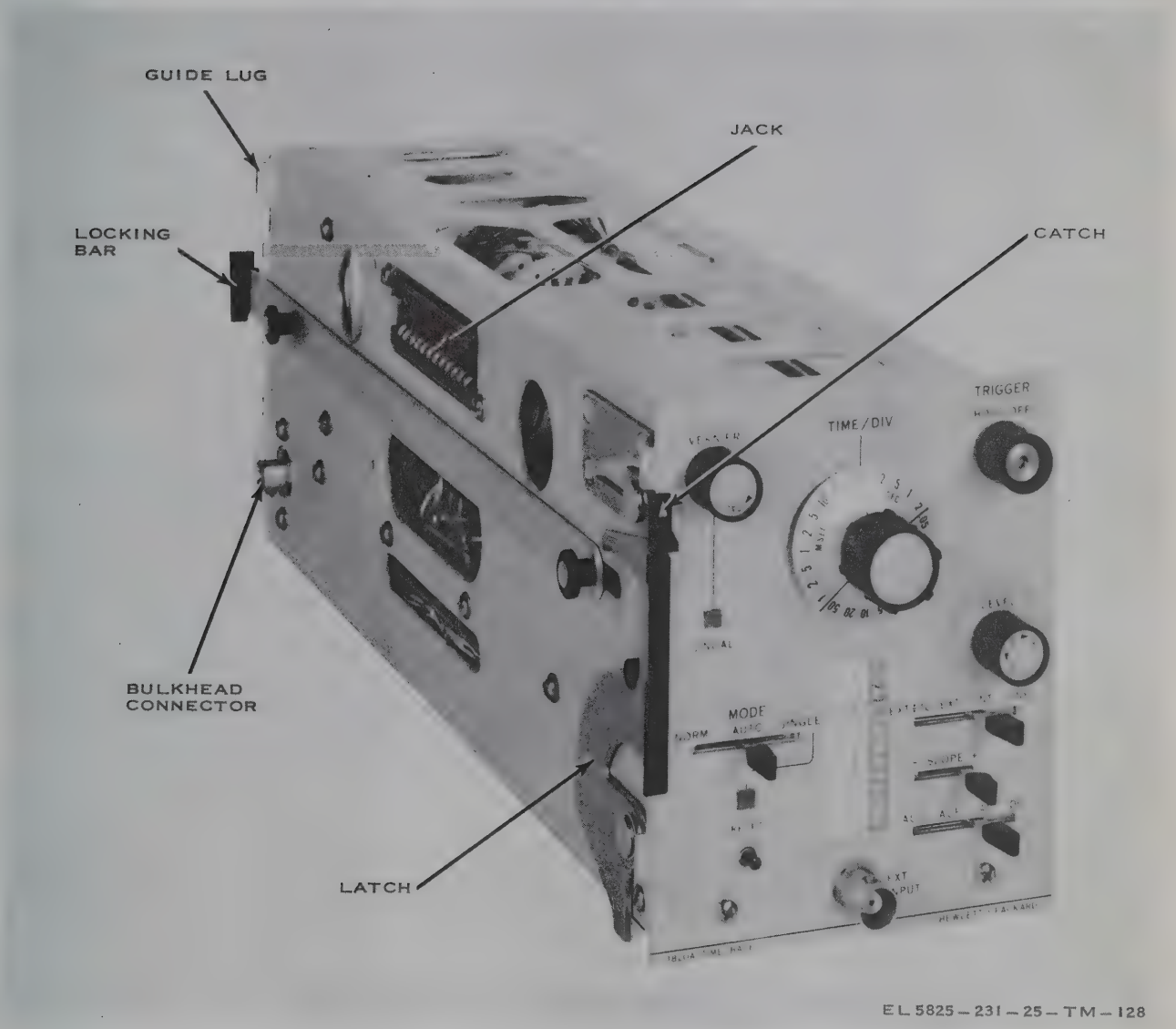


Figure 8–2. Plug-in mating.

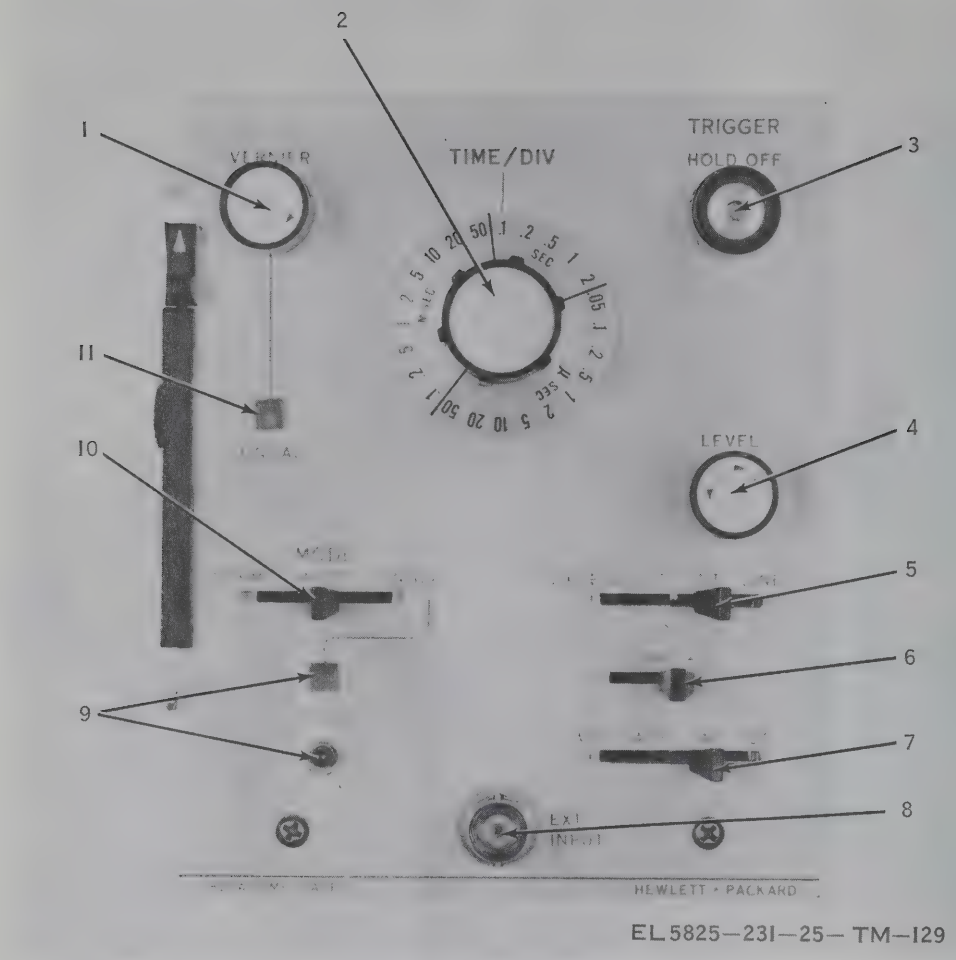


Figure 8–3. Plug-in unit, controls and connectors.

Section II. INSTALLATION AND OPERATION

8–4. Preparation for Use

a. Install plug-in to AN/USM–318(V)1 main frame as follows:

(1) Move locking bar (fig. 8–2) to rear, to prepare the two plug-in units for mating.

(2) Fit vertical unit plug into horizontal unit jack and press plug-ins firmly together.

CAUTION

Make certain that the bulkhead connectors are aligned before pressure is applied to plug.

(3) Be sure that guide lugs are properly mated and front and rear panels are aligned, then push locking bar forward.

(4) Lift up on the plug-in catch and rotate plug-in latch downward.

(5) Rotate plug-in latch upward and push forward to lock.

b. Install the assembled plug-ins into the AN/USM–318(V)1 frame by inserting assembled unit into space provided.

8–5. Controls and Connectors
(fig. 8–3)

Control or connector	*Purpose and use*
VERNIER (1)	Provides continuous adjustment between the calibrated positions of the TIME/CM switch. With VERNIER control fully cw, the UNCAL lamp will not be on and sweep speed can be read direct from the TIME/CM control.
TIME/CM (2)	Selects the time represented by each centimeter on the horizontal axis of the crt.
TRIGGER HOLD-OFF (3)	Adjusts the holdoff time between the end of one sweep and the beginning of the next.
LEVEL (4)	Selects the point on the trigger waveform that starts the sweep.
TRIGGER SOURCE switch (5)	Selects the signal source that starts the sweep.
SLOPE switch (6)	Determines the polarity of the trigger signal's slope that starts the sweep.
TRIGGER COUPLING switch (7)	Selects between direct coupling (dc) and three types of capacitive coupling (ac, acf, and acs).
EXT INPUT jack (8)	BNC connector for applying an external trigger signal.
RESET switch and lamp (9)	The pushbutton switch arms the sweep circuit in the SINGLE MODE. Indicator is lighted when circuit is armed.
MODE switch (10)	Selects a sweep that is triggered by the incoming signal (NORM); a sweep that is either triggered by the incoming signal or is free running (to provide a baseline) in the absence of an incoming signal (AUTO); or a sweep that is triggered only once and must be manually re-armed (SINGLE).
UNCAL lamp (11)	Indicator is lighted when VERNIER control is not fully cw and sweep time is not calibrated.

8–6. Operating Procedures

a. Triggering Signals. Refer to chart 8–1 for equipment settings to obtain proper trigger signaling. Figure 8–5 shows the proper trigger amplitude requirements necessary for frequencies up to 90 MHz.

Chart 8–1. Trigger Signal Requirements

SWEEP MODE	TRIGGER SOURCE	TRIGGER COUPLING	TRIGGER AMPLITUDE	LEVEL	SLOPE
N	LINE	DC: dc to 90 MHz	See Figure 8–5	Adjustable −50v to +50v	S E L E C T A B L E + or −
O	INT	AC: 20 Hz to 90 MHz			
R	EXT	ACF: 15 kHz to 90 MHz			
M	EXT÷10	ACS: 20 Hz to 30 kHz	10 times Figure 8–5	Adjustable −50v to +50v	
A	LINE	DC: 40 Hz to 90 MHz	See Figure 8–5	Adjustable −50v to +50v	
U	INT	AC: 40 Hz to 90 MHz			
T	EXT	ACF: 15 kHz to 90 MHz			
O	EXT÷10	ACS: 40 Hz to 30 kHz	10 times Figure 8–5	Adjustable −50v to +50v	
S	LINE	DC: dc to 90 MHz	See Figure 8–5	Adjustable −50v to +50v	
I	INT	AC: 20 Hz to 90 MHz			
N	EXT	ACF: 15 kHz to 90 MHz	10 times Figure 8–5	Adjustable −50v to +50v	
G	EXT÷10	ACS: 20 Hz to 30 kHz			
L					
E					

b. Normal Operation (fig. 8–6).

(1) Set HORIZONTAL DISPLAY (1) to INT.

(2) Set MODE (2) to AUTO.

(3) With INTENSITY and POSITION controls (3), locate baseline. Use FIND BEAM if necessary.

(4) Set controls of vertical plug-in as de-

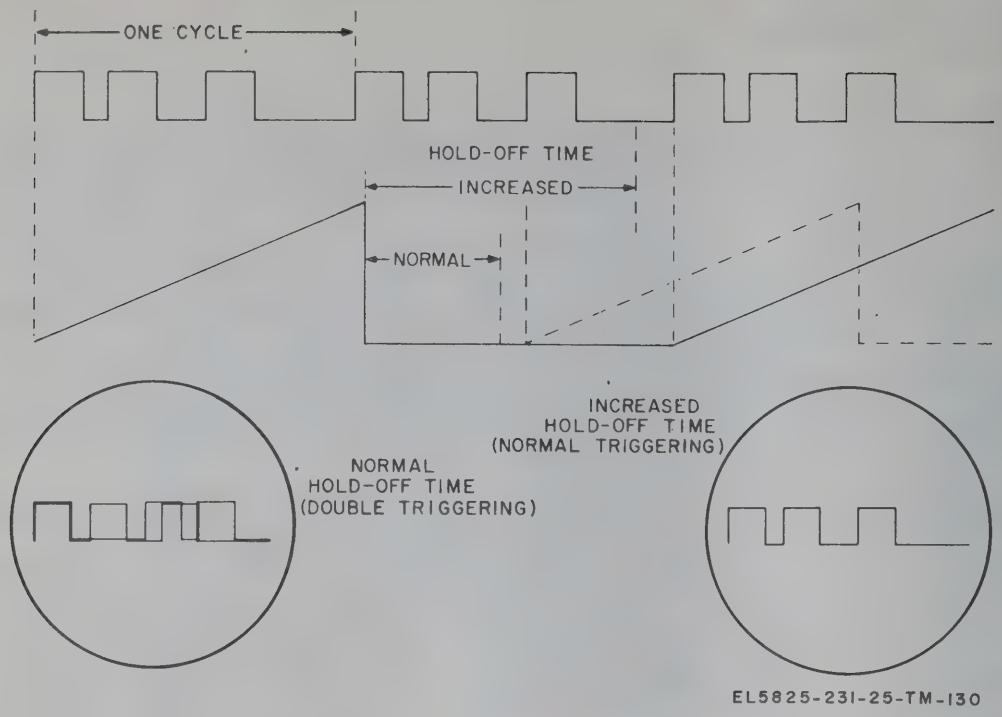


Figure 8-4. Trigger holdoff.

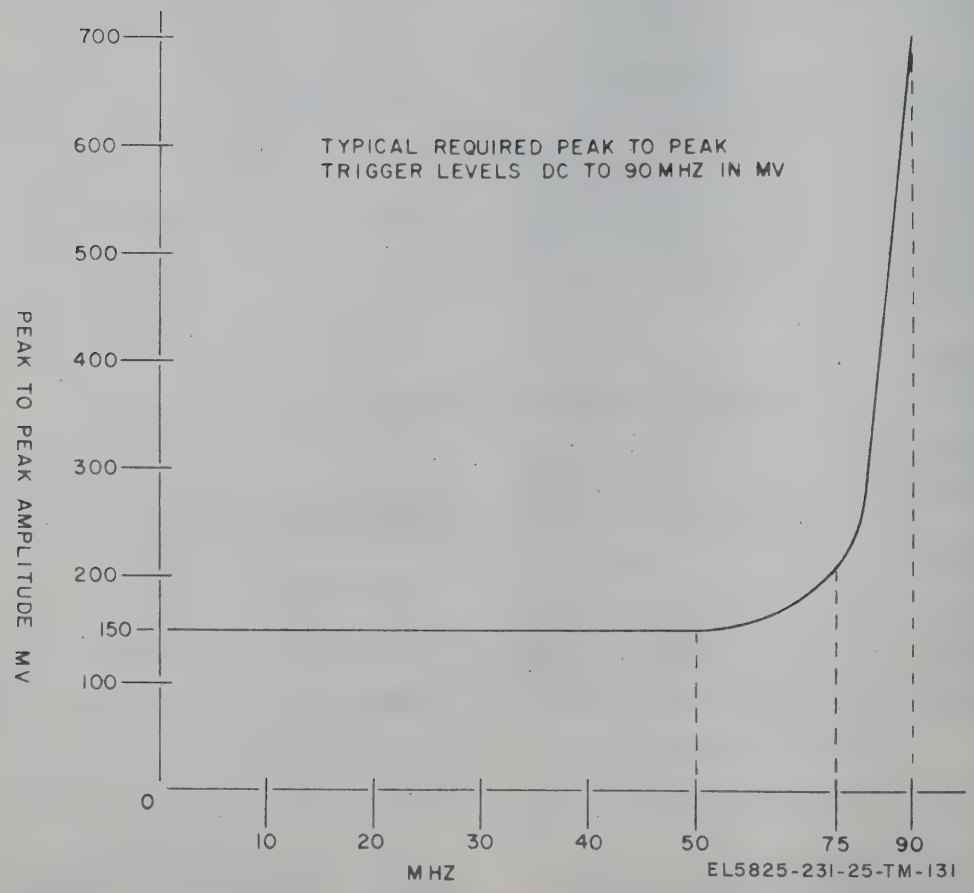


Figure 8-5. Trigger amplitude requirements.

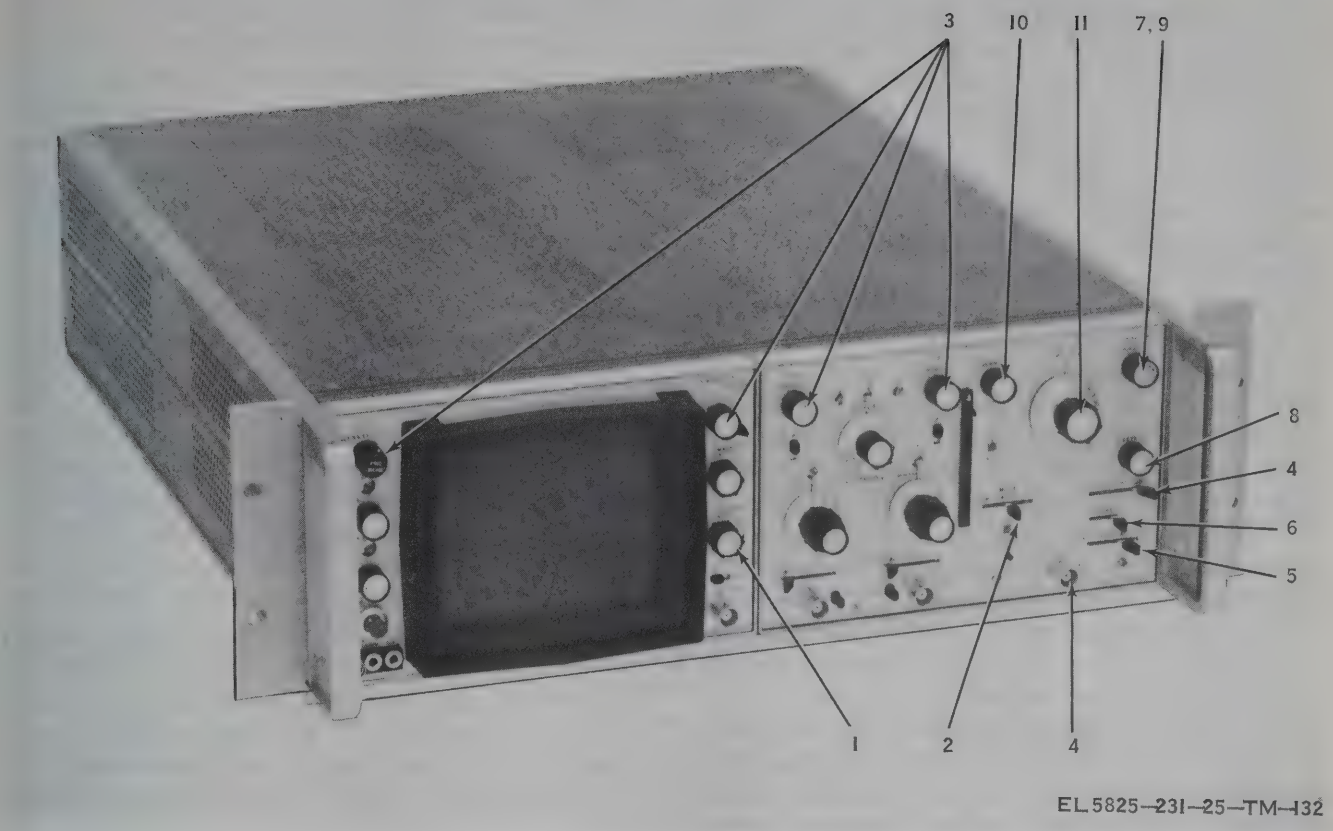


Figure 8–6. Monitor Oscilloscope AN/USM–318(V)1, normal operation, control settings.

sired (TM 11–6625–1703–15).

(5) Adjust horizontal display as follows:

(*a*) Set TRIGGER SOURCE (4) as desired (if EXT or EXT + 10 is selected, connect trigger to EXT INPUT).

(*b*) Set TRIGGER COUPLING (5) as desired.

(*c*) Set SLOPE (6) as desired.

(*d*) Rotate TRIGGER HOLD-OFF (7) fully ccw.

(*e*) Adjust LEVEL (8) for a stable display.

(*f*) If viewing complex waveforms, rotate TRIGGER HOLD-OFF (9) cw for a proper display.

(*g*) Rotate VERNIER (10) fully cw.

(*h*) Set TIME/CM (11) as desired.

c. Single Sweep Operation.

(1) Proceed as outlined in *b* above.

(2) Set MODE (2) to SINGLE.

(3) Press RESET pushbutton. The RESET indicator should light, showing that the sweep is armed.

(4) The first trigger input will start the sweep. After one sweep, the RESET indicator will extinguish. The sweep must be rearmed by pressing the RESET pushbutton for another display.

d. Sweep Magnification Operation. Adjust controls as outlined in *b* above.

(1) Set MAGNIFIER to X5 or X10.

(2) Adjust HORIZONTAL POSITION to view any part of the display.

(3) Divide TIME/CM setting by 5 in X5 or 10 or X10 to obtain actual time/cm.

Section III. FUNCTION AND MAINTENANCE

8–7. Block Diagram Description

a. The HP–1820A consists of trigger, gate, and sweep circuits (fig. 8–7). The sweep circuit can be triggered or set for free-run. When triggered operation is used, the required trigger signal is coupled to the trigger generator from one of three sources: EXT, INT, or LINE. Free-run operation is selected by setting the MODE switch

to AUTO. In this position, the sweep generator operates without a trigger signal, but if a trigger signal is applied, it will override the free-run operation and control the sweep. The TRIGGER COUPLING switch determines the type of coupling for the incoming trigger signal. The SLOPE switch selects triggering on either the positive or negative-going portion of the incoming trigger signal; the LEVEL control sets the triggering voltage point on the selected slope of the incoming signal. The output of the trigger generator is a fast rise negative spike which starts the gate generator.

b. When triggered, the gate generator produces a negative rectangular pulse which is applied to the oscilloscope for unblanking the crt, and to the integrator in the sweep circuit.

c. The integrator circuit is normally clamped so that its output is a constant dc voltage. The negative gate signal unclamps the integrator which starts generating the sweep, a positive-going sawtooth signal. This sweep signal is applied to the oscilloscope for horizontal deflection.

d. A portion of the sweep signal is also applied to the Schmitt trigger and holdoff circuits (fig. 8–4). When the ramp reaches a predetermined amplitude, the Schmitt trigger changes state, turning the gate generator off and stopping the ramp. After a time delay starting at the end of the ramp, the holdoff circuit generates a negative signal which switches the Schmitt trigger circuit back to its pretrigger state. The duration of this time delay is determined by the holdoff control. This action resets the gate generator so that the next negative spike from the trigger generator will trigger the gate generator, repeating the cycle.

e. When operating in AUTO, the auto circuit is triggered by the Schmitt trigger at the same time that the gate generator is reset. The auto circuit then produces a negative signal which triggers the gate generator. This action forces the sweep to free-run at a rate determined by the TIME/CM switch. If a signal 40 Hz or greater is applied to the trigger generator, it will override the auto circuit and control the sweep.

f. When the MODE switch is in the SINGLE position, the holdoff circuit is disconnected from the Schmitt trigger. The gate generator must now be reset by manually switching the Schmitt trigger to its pre-trigger state at the end of each sweep.

8–8. Circuit Function

a. Normal Sweep Function (fig. FO–23).

(1) Three sources of trigger signals can be used, as selected by TRIGGER SOURCE switch S101. External triggers are applied through J101, a front panel BNC connector. In EXT ÷ 10, voltage divider R103/R104 attenuates the external input signal 10 times. Internal triggers are received through P2 from the vertical plug-in and are coupled through emitter followers Q101 and Q102. When LINE is selected as a trigger, a 20-volt peak-to-peak powerline signal is applied to P1 pin 31 from the AN/USM–318(V)1 and is attenuated to 10-volt peak-to-peak by voltage divider R101/R102. From S101, the desired trigger signal is fed to TRIGGER COUPLING switch S102 which permits direct (dc), capacitive (ac), low-pass filter (acs), or high-pass filter (acf) coupling of the trigger signal to source follower Q103. Diode CR103 protects Q103 from excessive negative voltage. Diode Q103 acts as a high input impedance for the trigger signal and couples it to trigger comparator Q104/Q105.

(2) LEVEL control R121, through emitter follower Q106, controls the bias for Q104 and Q105. When the signal voltage at the base of Q104 exceeds the potential at the base of Q105, tunnel diode CR106 is switched to its high-voltage state by either Q104 or Q105, depending upon the setting of SLOPE switch S103. When S103 is set to + (positive), some positive amplitude on the trigger signal, as determined by the LEVEL control, will overcome the bias on Q104; Q104 conducts through CR107 to CR106, switching it to its high-voltage state. If S103 is switched to − (negative), some negative amplitude on the trigger signal will overcome the bias on Q105. Transistor Q105 will conduct through CR108 to CR106, switching it to its high-voltage state.

(3) The negative-going rectangular wave produced by CR106 is coupled by C120 to the emitter circuit of Q107. The output of Q107 is differentiated by C121 and the input circuit of Q108. Transistor Q108 is biased at cutoff; therefore, only the positive pulses are amplified and inverted.

(4) In the gate circuit, the negative spike from Q108 is coupled to tunnel diode CR201. Before this, incoming signal, CR201 is biased in a low-voltage state and is applied to the base of Q212. This negative potential cuts off Q212, and its positive-going collector voltage coupled to the base of Q211 turns Q211 on. With Q211 conducting, tunnel diode CR201 regains its arming current and returns the circuit to a standby condition. Upon receipt of another incoming trigger signal, the entire operation recycles. Whenever Q211 is on, Q210 is also on, shorting R242

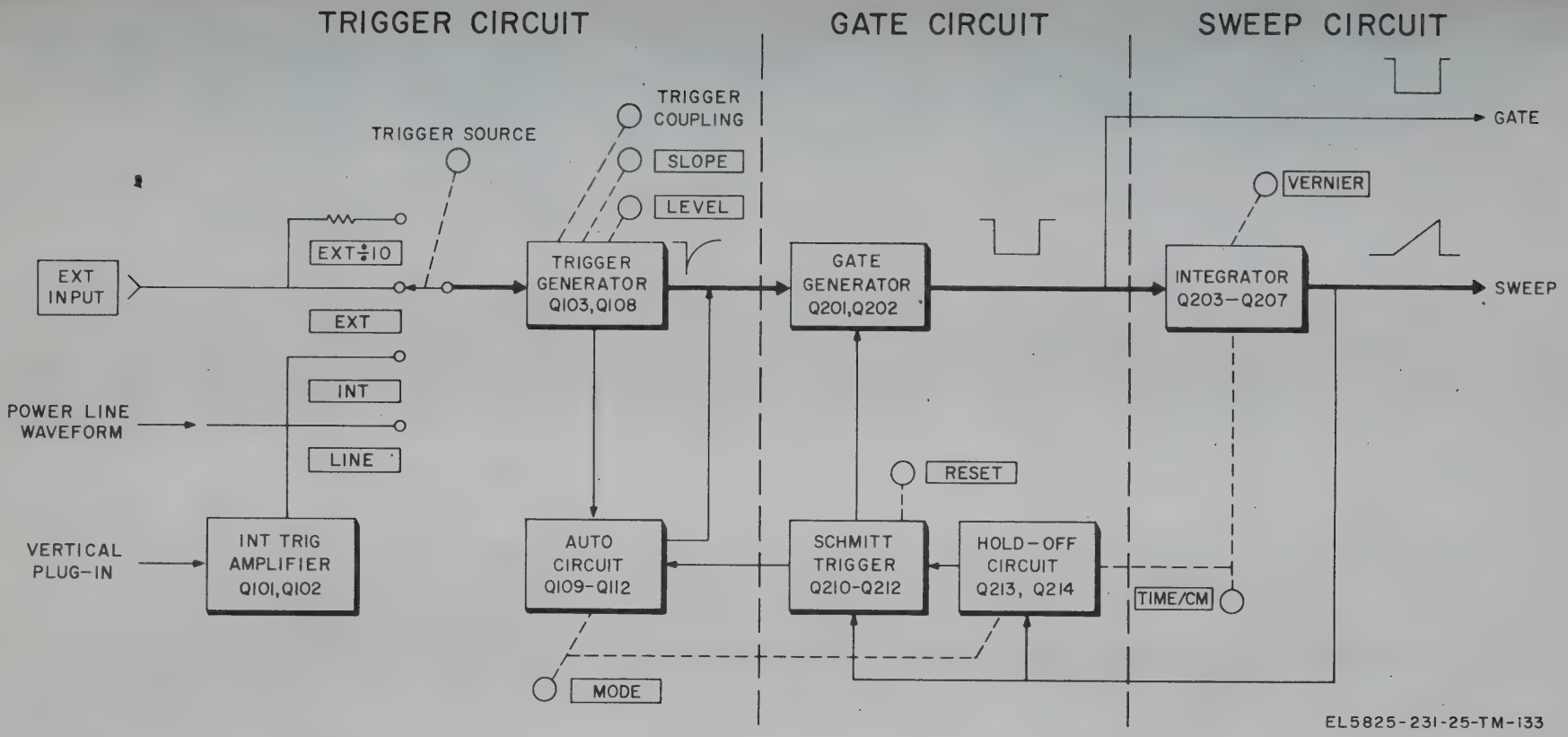


Figure 8–7. Plug-in unit, 1820A, functional block diagram.

and lighting DS201 which indicates that CR201 is reset.

b. Auto Sweep Function (fig. FO–23).

(1) During NORM operation, free-run lockout transistor Q112 is conducting and its negative collector voltage, coupled through CR114, keeps free-run gate generator Q109 cutoff. In AUTO operation, a negative supply voltage applied to Q112 base through S104 and CR117, keeps Q112 cutoff. With Q112 cutoff, the base of free-run gate generator Q109 is free to follow any voltage change on Q212 collector. At the end of the holdoff period, the collector voltage of Q212 moves in a positive direction and this voltage change is applied to the base of Q211 and Q109. Transistor Q211 conducts and again supplies current to tunnel diode CR201. Free-run gate generator Q109 also conducts and its collector current is enough to switch CR201 to its high-voltage state. With CR201 at a high-voltage state, the negative gate required to start the sweep is generated and free-run operation is achieved.

(2) If a trigger signal 40 Hz or faster is applied during AUTO operation, the negative trigger pulse on the collector of Q108 is coupled through CR116 to Q111 base. This negative pulse turns on Q111 and its collector moves in a positive direction, reverse biasing CR117 and allowing free-run lockout Q112 to conduct. Transistor Q109 is now cutoff by the negative voltage from the collector of Q112. With Q109 cutoff, the current source for CR201 is removed, and an incoming trigger signal is required to switch the tunnel diode to a high-voltage state and start the sweep.

(3) Capacitor C125 in the collector of Q111 is discharged by the trigger pulse through Q11. The capacitor starts charging at the end of the trigger, but charging time is long. If the incoming frequency is approximately 40 Hz or faster, C125 will remain only partially charged and the circuits will synchronize with the incoming trigger. However, if the trigger frequency is less than approximately 40 Hz, or is removed, C125 will charge enough to forward bias CR117, cutting off Q112 and permitting Q109 to conduct. Once again the operation is free-run.

c. Single Sweep Function (fig. FO–23).

(1) Circuit functioning remains the same in SINGLE operation as in NORM with one exception. The negative voltage from the holdoff circuit that returns the Schmitt trigger to its armed condition is removed by S104. Therefore, the Schmitt trigger will switch to its unarmed state and end the sweep as previously described. This state will continue until the RESET pushbutton switch is pressed.

(2) When RESET pushbutton is pressed, a negative voltage is applied to the base of Q212. This action turns off Q212, permitting Q211 to conduct. With Q211 conducting, CR201 is armed and will permit one sweep upon receipt of an incoming trigger. Although Q211 is conducting, it is not enough to put CR201 in its high-voltage state. When the incoming trigger arrives at the cathode of CR201, it provides enough additional current to put the diode in its high-voltage state. After the trigger pulse ends, the current from Q211 alone is sufficient to keep CR201 in this state. Tunnel diode CR201 produces a negative signal which is amplified by Q201 and Q202. Diodes CR202, CR203, and CR204 keep Q201 from saturating. The negative pulse at the collector of Q202 is fed through P1 pin 17 to the AN/URM–381(V)1 for crt unblanking; to P1 pin 14 and through the oscilloscope to a rear panel BNC connector; and to the junction of CR206/CR207.

(5) *Sweep Circuit* (fig. FO–23, and FO–24). The negative pulse from Q202 reverse biases diode switch CR206/CR207, permitting the timing capacitors (C302–C312) to charge through the timing resistors (R301–R310) to the negative potential on the wiper of R214. The TIME/CM switch, by selecting various time constants and controlling the bias for Q203, determines the slope of the negative-going ramp at the gate of Q204. VERNIER control R214 adjusts the charge rate between the calibrated steps of the TIME/CM switch.

(6) The negative sweep is coupled through Q204 to the base of Q205. Transistor Q204 provides a high input impedance for the sweep and R221 adjust the quiescent operating point of the circuit. The negative sweep is amplified and inverted by Q205 and coupled through emitter follower Q206.

(7) From the emitter of Q206, the positive sweep is applied to P1 pin 1 for horizontal deflection in the AN/USM–318(V)1 oscilloscope; P1 pin 11, through the oscilloscope to a rear panel BNC connector; and fed back to the selected timing capacitor to assure a linear sweep output.

(8) A portion of the sweep signal is applied to emitter follower Q207 and sent on to the Schmitt trigger circuit. The sweep voltage at the base of Q212 goes positive until it reaches the upper hysteresis limit of the Schmitt trigger, turning Q212 on and cutting Q211 off.

The amount of sweep time for this action to occur is controlled by SWEEP LENGTH adjustment R232. When Q211 ceases to conduct, the current to CR201 is removed and the tunnel diode switches to its low-voltage state. The negative gate ceases; CR206 and CR207 are forward biased, ending the ramp and discharging the selected timing capacitor. Because CR201 is no longer receiving current from Q211, any further incoming triggers have no effect.

(9) As the sweep was generated, a portion of the positive sweep was also fed to the holdoff emitter follower Q214. The positive-going emitter of Q214 forward biases CR219, permitting the negatively charged holdoff capacitors (C320–C–350) to discharge. When the ramp ends, CR219 is again reverse-biased and the holdoff capacitor begins to charge negatively. Holdoff time (charge time of the capacitor) is determined by the rc time constant of R263 and the particular holdoff capacitor selected. Resistor R265 permits calibration of the holdoff time.

(10) When the holdoff capacitor has charged to some predetermined negative potential, this negative voltage, coupled through Q213, forward biases CR218. With diode CR218 forward biased, a negative voltage is applied to the base of Q212. This negative potential cuts Q212 off, and its positive-going collector voltage coupled to the base of Q211 turns Q211 on. With Q211 conducting, tunnel diode CR201 regains its arming current and returns the circuit to a standby condition. Upon receipt of another incoming trigger signal, the entire operation recycles. Whenever Q211 is on, Q210 is also on, shorting R242 and lighting DS201 which indicates that CR201 is reset.

8–9. Maintenance Instructions

Periodic maintenance of the time base plug-in unit is scheduled as outlined in TM 11–6625–1703–15.

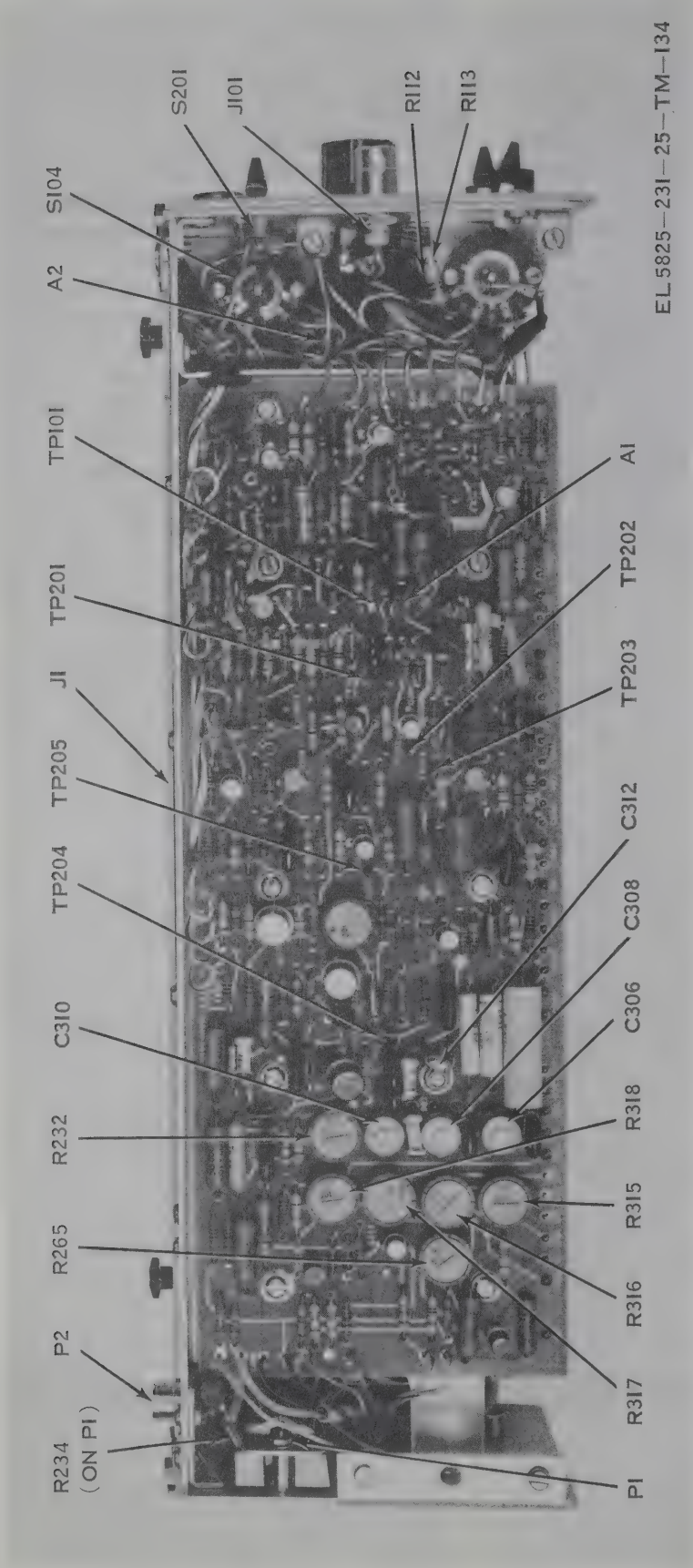


Figure 8-8. Adjustment and test point location.

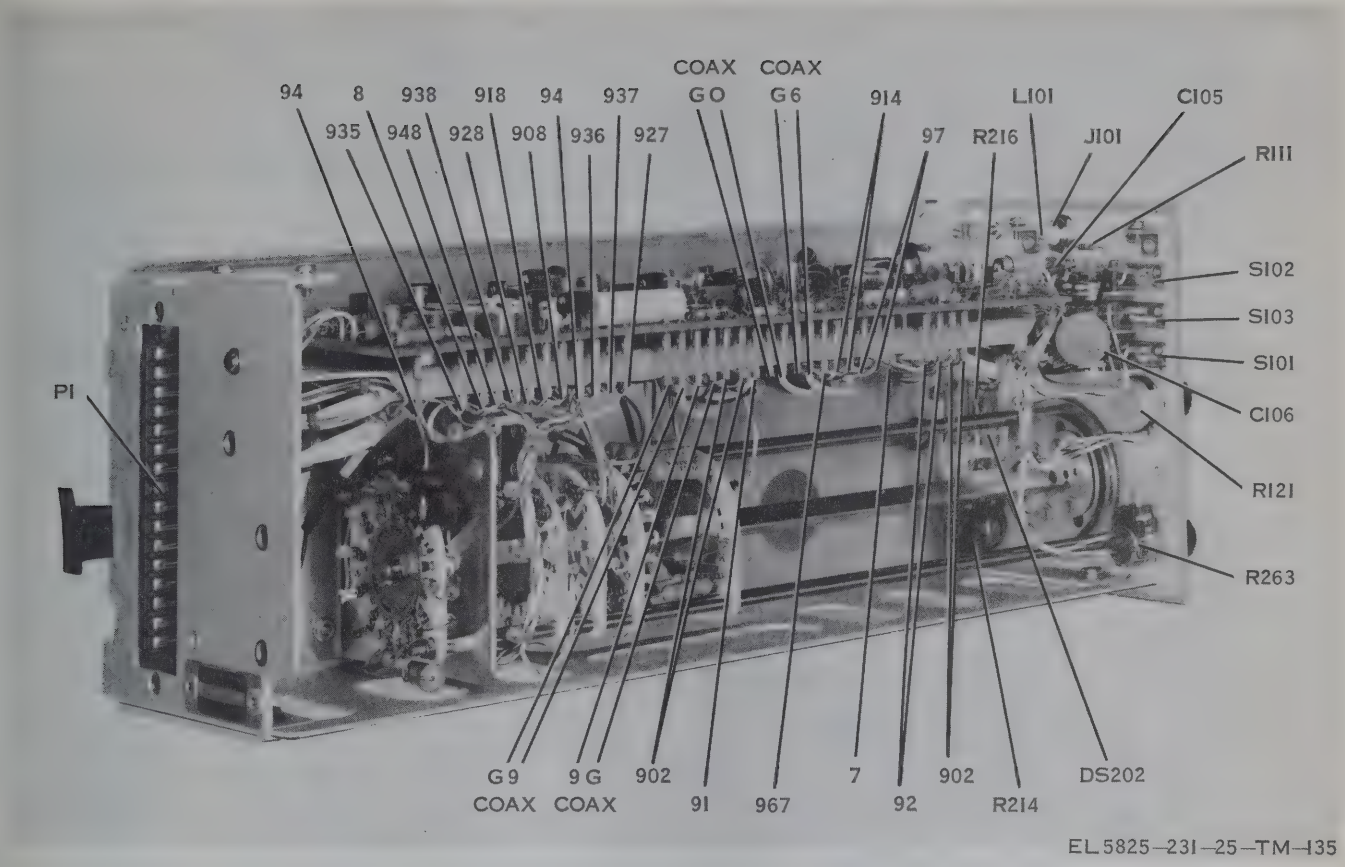


Figure 8-9. Location of front panel components and clip-on wire leads.

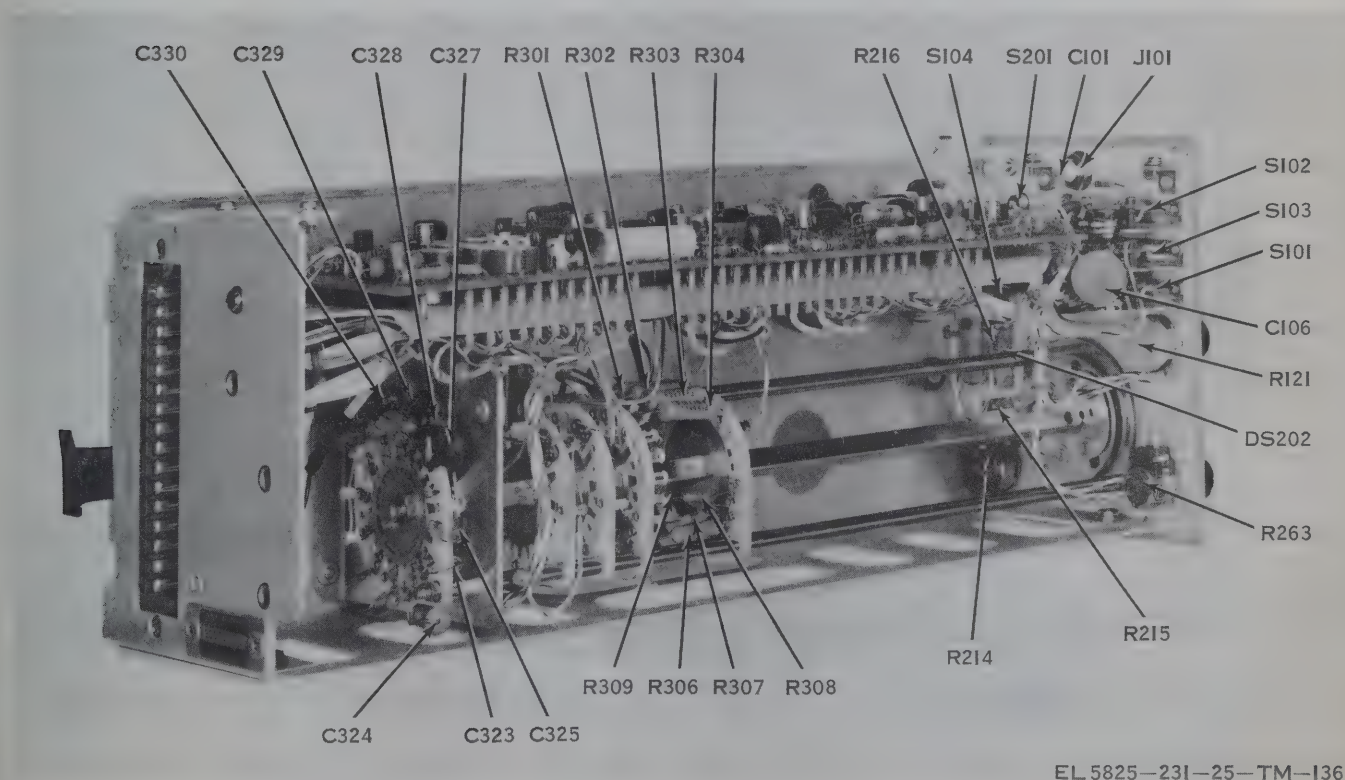


Figure 8-10. Switch and panel assembly, location of components.

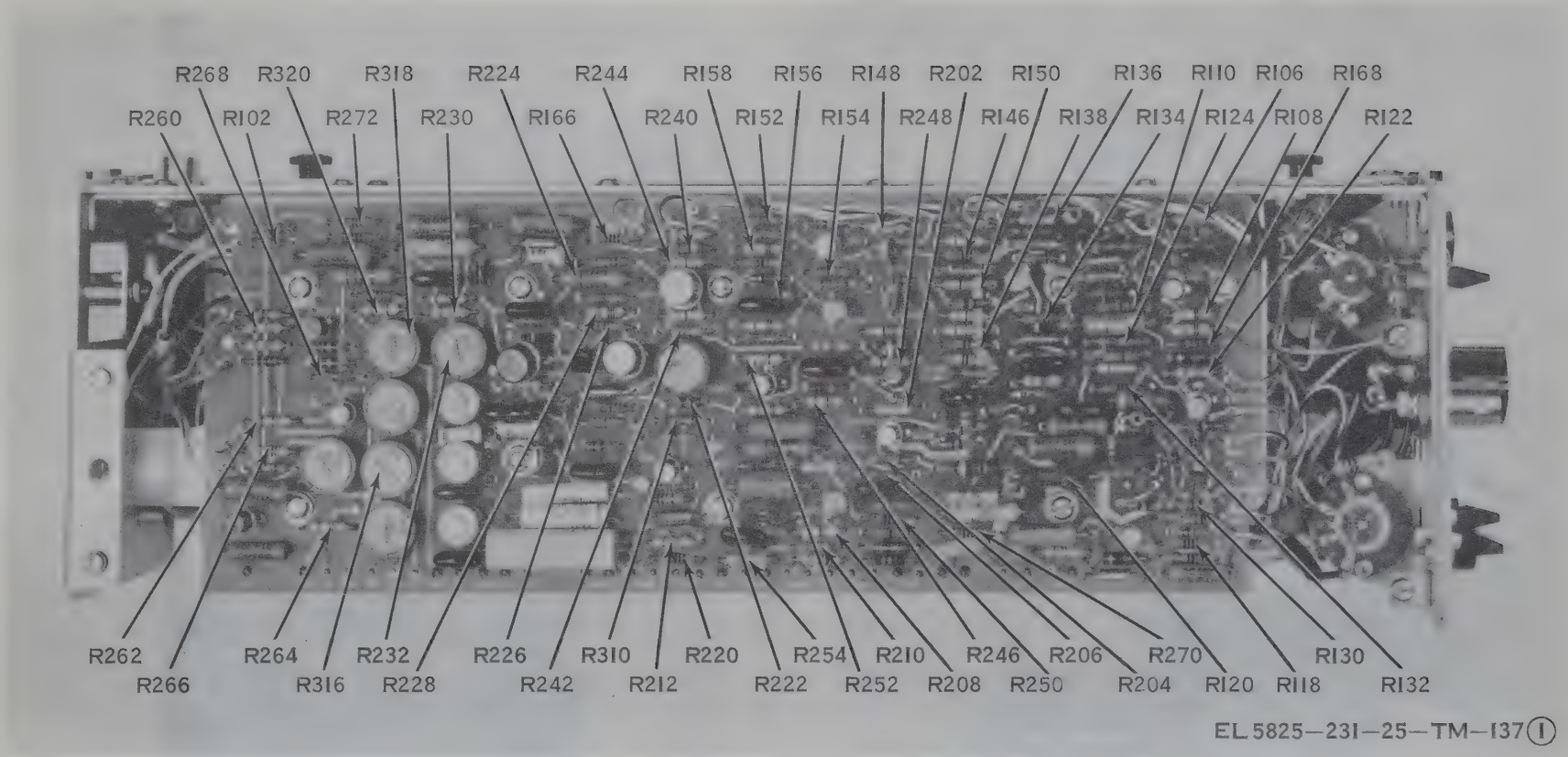


Figure 8–11①. Main circuit board, location of components, resistors, (sheet 1 of 2).

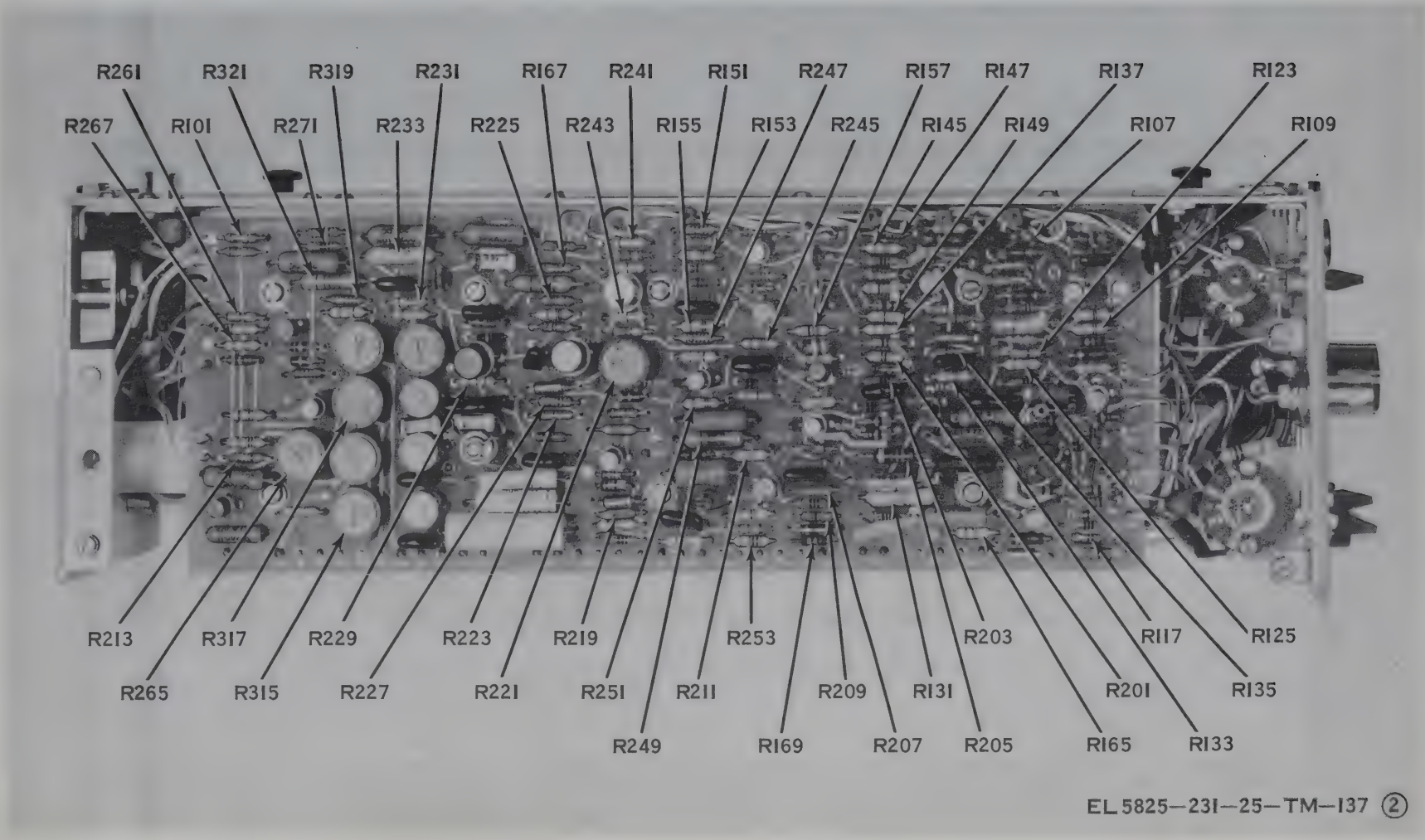


Figure 8–11②. Main circuit board, location of components, resistors (sheet 2 of 2).

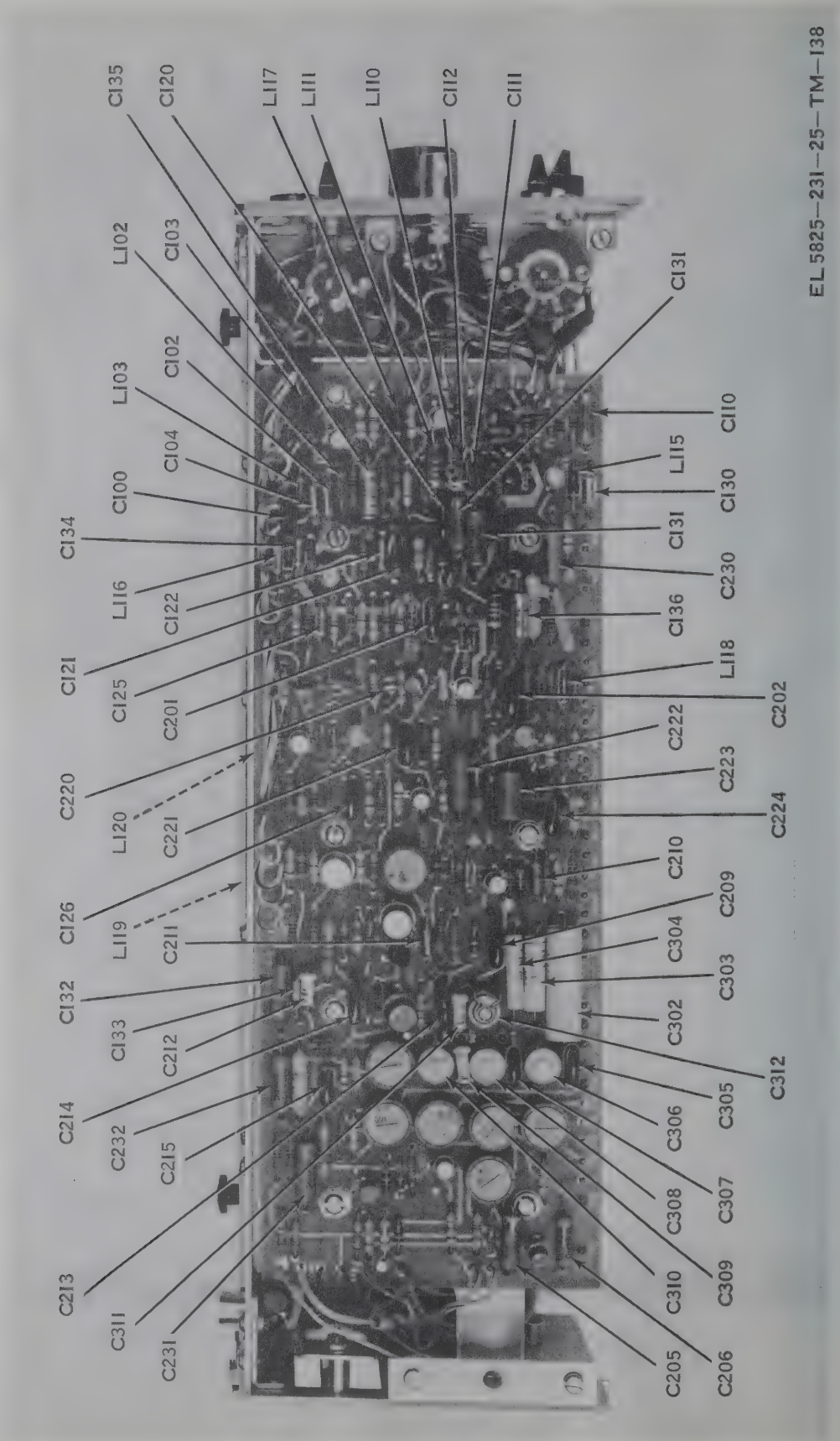


Figure 8–12. Main circuit board, location of components, inductors and capacitors.

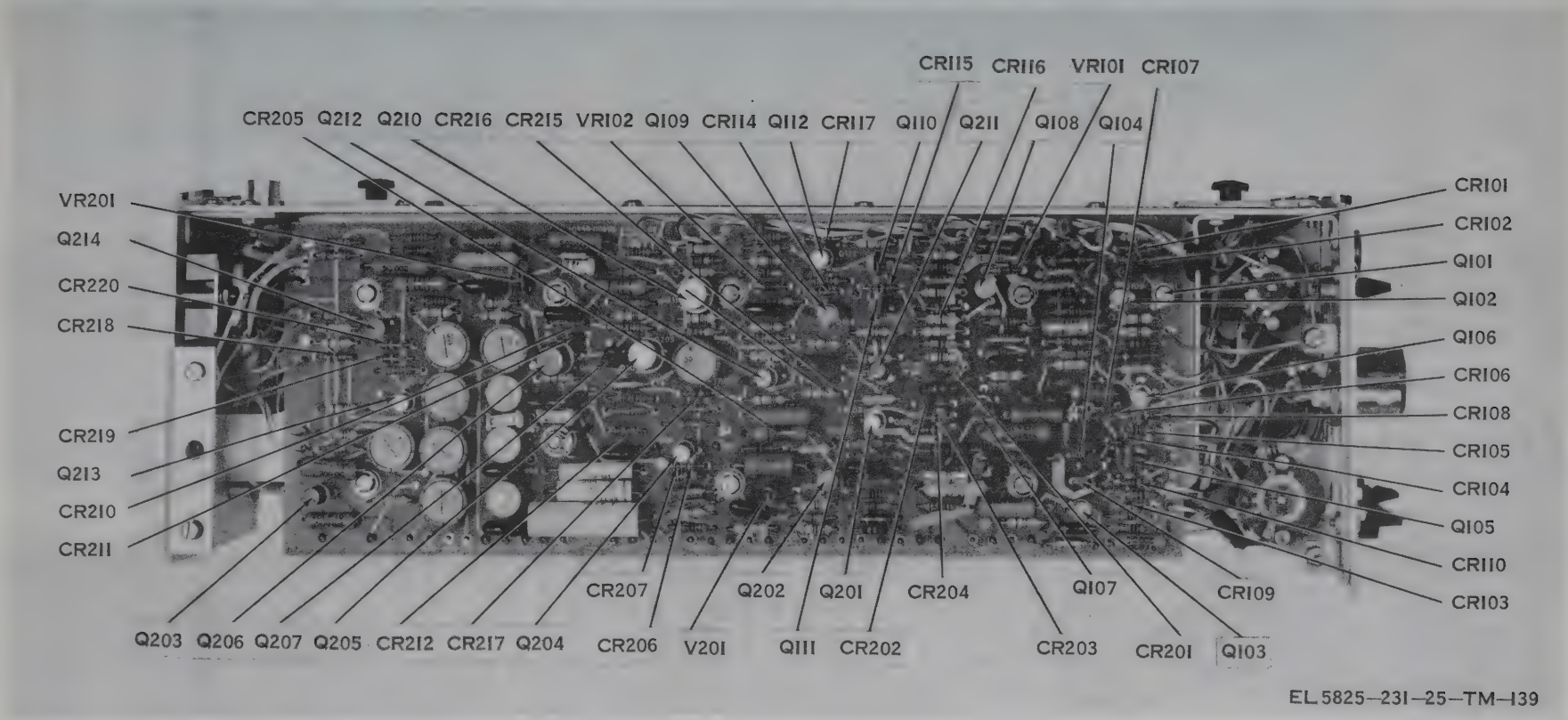


Figure 8–13. Main circuit board, location of components, semiconductors.

Section IV. TROUBLESHOOTING

8-10. General

Schematic diagrams show circuit operation. A given schematic diagram may include all or part of several assemblies. Dc voltages and waveform test points (fig. 8-8 through 8-13) are also provided on the schematic diagrams. Dc voltage measurement conditions, waveform measurement conditions, and waveforms applicable to each schematic diagram are shown adjacent to that schematic diagram.

8-11. Test Equipment Required

Federal stock No.	*Equipment*	*References*
6625-539-9685	Generator, Signal AN/USM-44A	TM 11-6625-508-10
6625-740-0344	Test Set, Telephone AN/USM-181	TM 11-6625-602-12
6625-911-6368	Counter, Electronic Digital Readout AN/USM-207	TM 11-6625-700-10
6625-643-1670	Voltmeter, Electronic ME-30B/U	TM 11-6625-320-12
6625-913-9781	Multimeter ME-26B/U	TM 11-6625-200-15
6625-228-2201	Oscilloscope AN/USM-281A	TM 11-6625-1703-15

8-12. Troubleshooting Procedures

a. Procedures.

(1) The first and most important prerequisite for successful troubleshooting is a thorough understanding of instrument operation and function. Often, suspected malfunctions are caused by improper control settings such as intensity set too low, display selector or mode switch in wrong position, trigger level maladjusted, etc.

(2) Dc voltages for most active components (transistors, field effect transistor (FET), etc.) are indicated on the schematic diagrams. Waveform test points are also shown on the schematic diagrams at various points along the main signal path. The numbers inside the test point symbols are keyed to the proper waveform (fig. 8-17) adjacent to the schematic diagram. These voltages and waveforms are invaluable for troubleshooting the instrument. Applications include checking stage gain, locating unbalance in differential amplifiers, locating faulty transistors, etc. Always refer to the specific measurement conditions before using dc voltages or waveforms. Allow the level to stabilize before noting dc voltages. Small dots are etched on circuit board assemblies next to the emitter lead of transistors, the source leads of FET's, the cathode side of diodes, and the positive side of electrolytic capacitors as an aid to locating test points.

CAUTION

When making waveform or dc voltage measurements, be extremely careful to avoid shorting supply voltages or components.

(3) If a malfunction occurs, troubleshooting flowcharts (fig. 8-14, 8-15, and 8-16 may help isolate the trouble to a particular circuit. Always begin troubleshooting with a visual inspection. Check for burned or loose components, loose wire connections, faulty switch contacts, or any similar conditions suggesting a source of trouble.

b. Repairs and Replacements (fig. 8-14).

(1) Almost all electrical components are accessible for replacement from the component side of the etched circuit board. Small dots are etched on the circuit board assemblies next to the emitter lead of transistors, the source leads of FET's the cathode side of diodes, and the positive side of electrolytic capacitors as an aid to repair. Mechanical and miscellaneous electrical parts are listed in TM 11-5825-231-25P. All wiring is color coded by use of colored tracers on wire insulation. Wire color is identified by standard RETMA color coding as used on resistors and capacitors.

(2) Etched circuit boards in this instrument have components mounted on one side of the board, conductive surfaces on both sides, and plated-through component mounting holes. Important considerations are as follows:

(*a*) Use low heat (37 to 47.5 watts, less than 800° F idling temperature), slightly bent chisel tip (1/16 to 1/8 inch diameter) soldering iron, and a small diameter high tin content solder. If a rosin solder is used, clean the area thoroughly after soldering.

(*b*) Components may be removed by placing the soldering iron on the component lead from other side of the board and pulling up on the lead. If heat is applied to the component side of the board, greater care is required to avoid damaging the component (especially for semiconductors). If heat damage is liekly to occur grip the lead with a pair of pliers to provide a heat sink between the soldering iron and com-

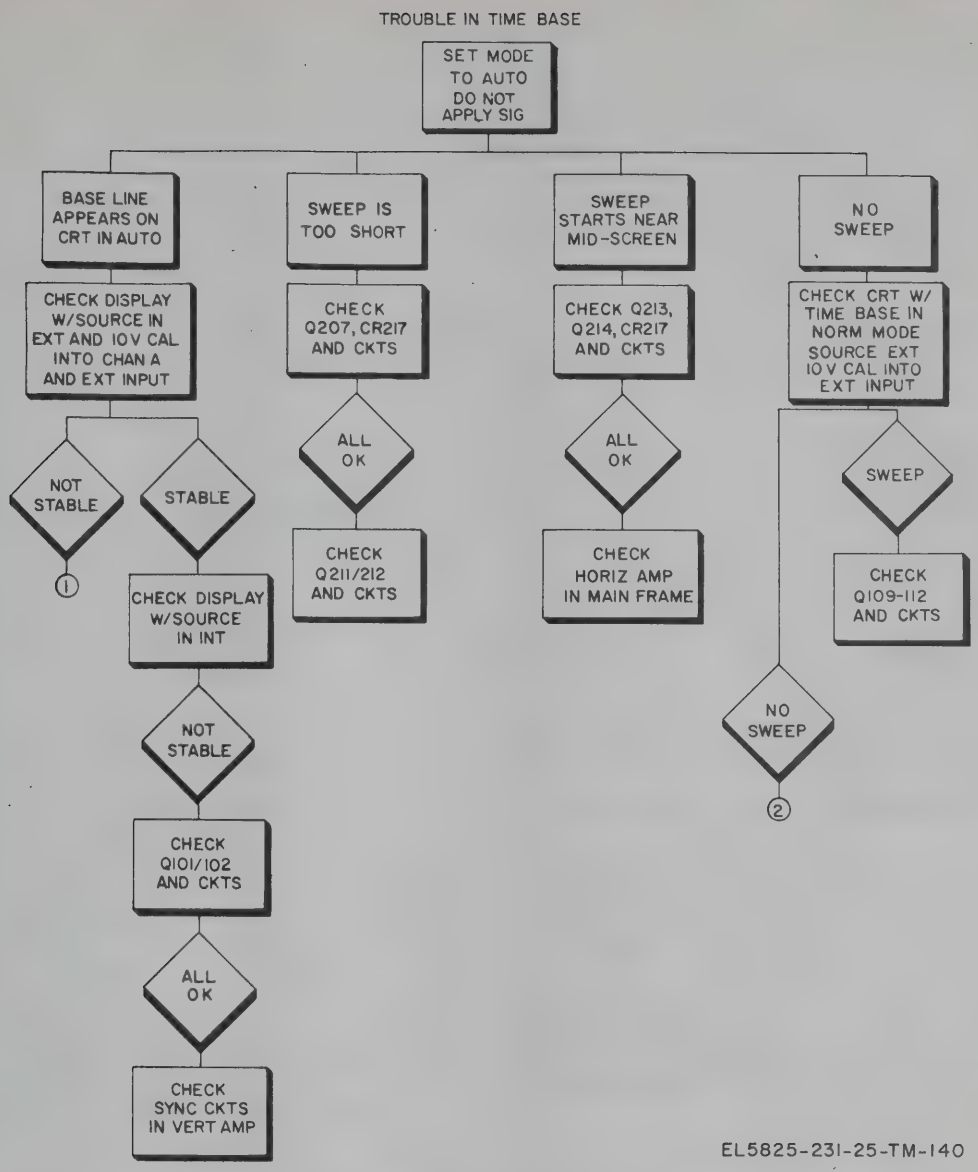

TROUBLE IN TIME BASE
SET MODE TO AUTO DO NOT APPLY SIG
BASE LINE APPEARS ON CRT IN AUTO
SWEEP IS TOO SHORT
SWEEP STARTS NEAR MID-SCREEN
NO SWEEP
CHECK DISPLAY W/SOURCE IN EXT AND 10V CAL INTO CHAN A AND EXT INPUT
CHECK Q207, CR217 AND CKTS
CHECK Q213, Q214, CR217 AND CKTS
CHECK CRT W/ TIME BASE IN NORM MODE SOURCE EXT 10V CAL INTO EXT INPUT
NOT STABLE
STABLE
ALL OK
ALL OK
SWEEP
CHECK Q211/212 AND CKTS
CHECK HORIZ AMP IN MAIN FRAME
CHECK Q109-112 AND CKTS
1
CHECK DISPLAY W/SOURCE IN INT
NO SWEEP
2
NOT STABLE
CHECK Q101/102 AND CKTS
ALL OK
CHECK SYNC CKTS IN VERT AMP
EL5825-231-25-TM-140

Figure 8–14. Troubleshooting flow chart, overall plug-in unit.

ponent.

(*c*) If a component is obviously damaged or faulty, clip the leads close to the component and then unsolder the leads from the board.

(*d*) Large components, such as potentiometers, may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free (the alternative is to clip the leads of a damaged part).

(*e*) Because the conductor portion of the etched circuit board is a metal plated surface covered with solder, be careful to avoid overheating which causes the conductor to lift away from the board. A lifted conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method of repair is to solder a section of copper wire along the damaged area.

(*f*) Clear the solder from the component hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed nonmetallic object, such as a toothpick.

(*g*) Shape the new component leads and clip to proper length. Insert the leads into the holes, apply heat and solder (preferably on the side opposite the component).

8–13. Final Testing and Adjustment

a. Final Testing (fig. 8–8 through 8–18, FO–22, FO–23, FO–24).

The performance check must be done in the given sequence because succeeding steps depend on the control settings and results of the previous steps.

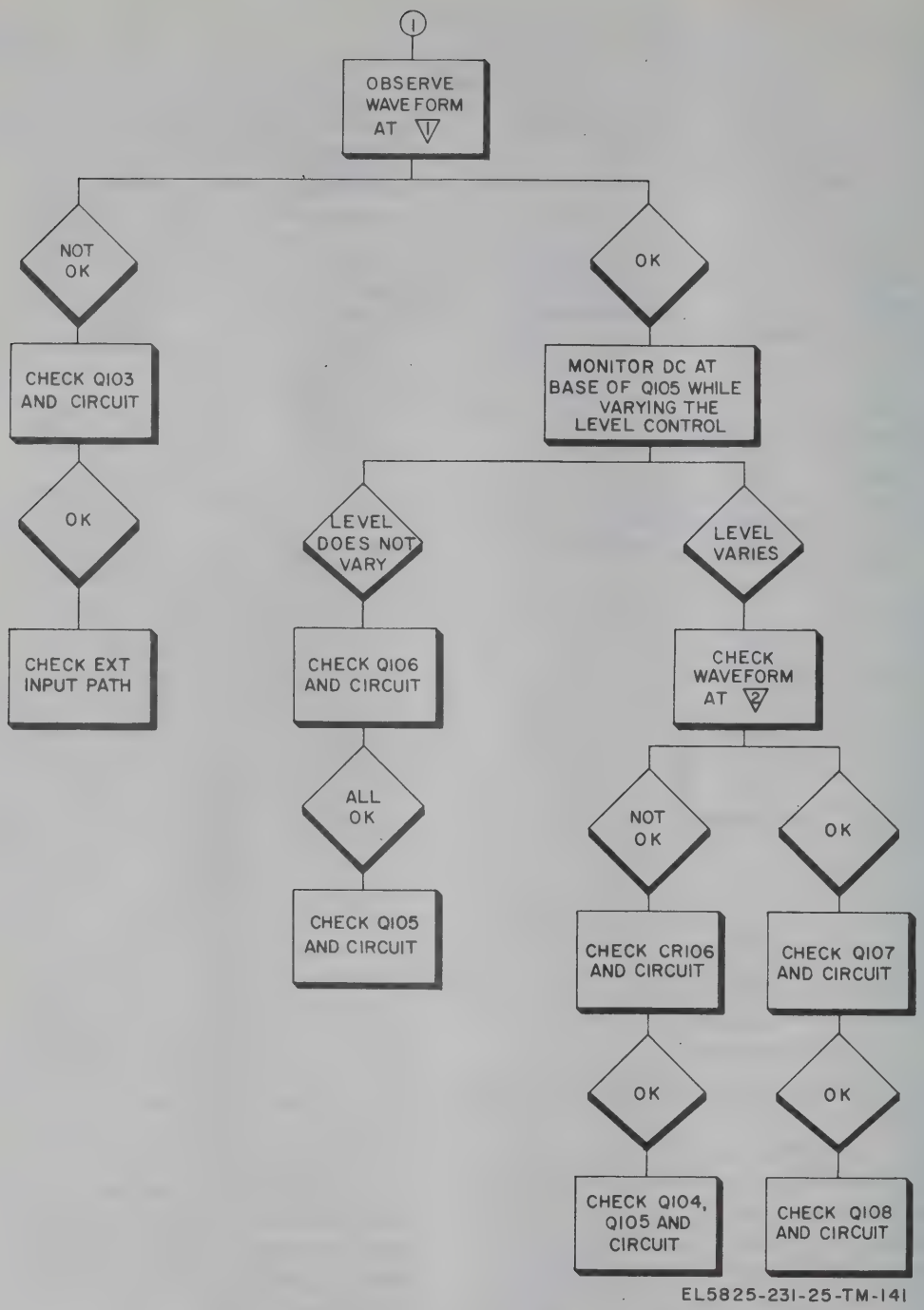


Figure 8–15. Troubleshooting flow chart, trigger operator.

(1) *Preliminary.* Lock the plug-ins together and install in a calibrated AN/USM–318(V)1. Apply power and allow a 15 minute warmup before proceeding.

(2) *Initial control settings.*

(*a*) Oscilloscope AN/USM–318(V)1.

HORIZONTAL MAGNIFIER	X1
HORIZONTAL DISPLAY	INT

(*b*) Vertical plug-in:

DISPLAY	A
A POLARITY	+UP
A VERNIER	CAL
A VOLTS/CM	0.1
A COUPLING	AC

(*c*) Model 1820A Time Base:

VERNIER	CAL
TIME/CM	0.05 μSEC/CM
TRIGGER HOLD-OFF	NORM
TRIGGER SOURCE	EXT
TRIGGER COUPLING	AC
SLOPE	+ (positive)
MODE	AUTO

(3) *Trigger.*

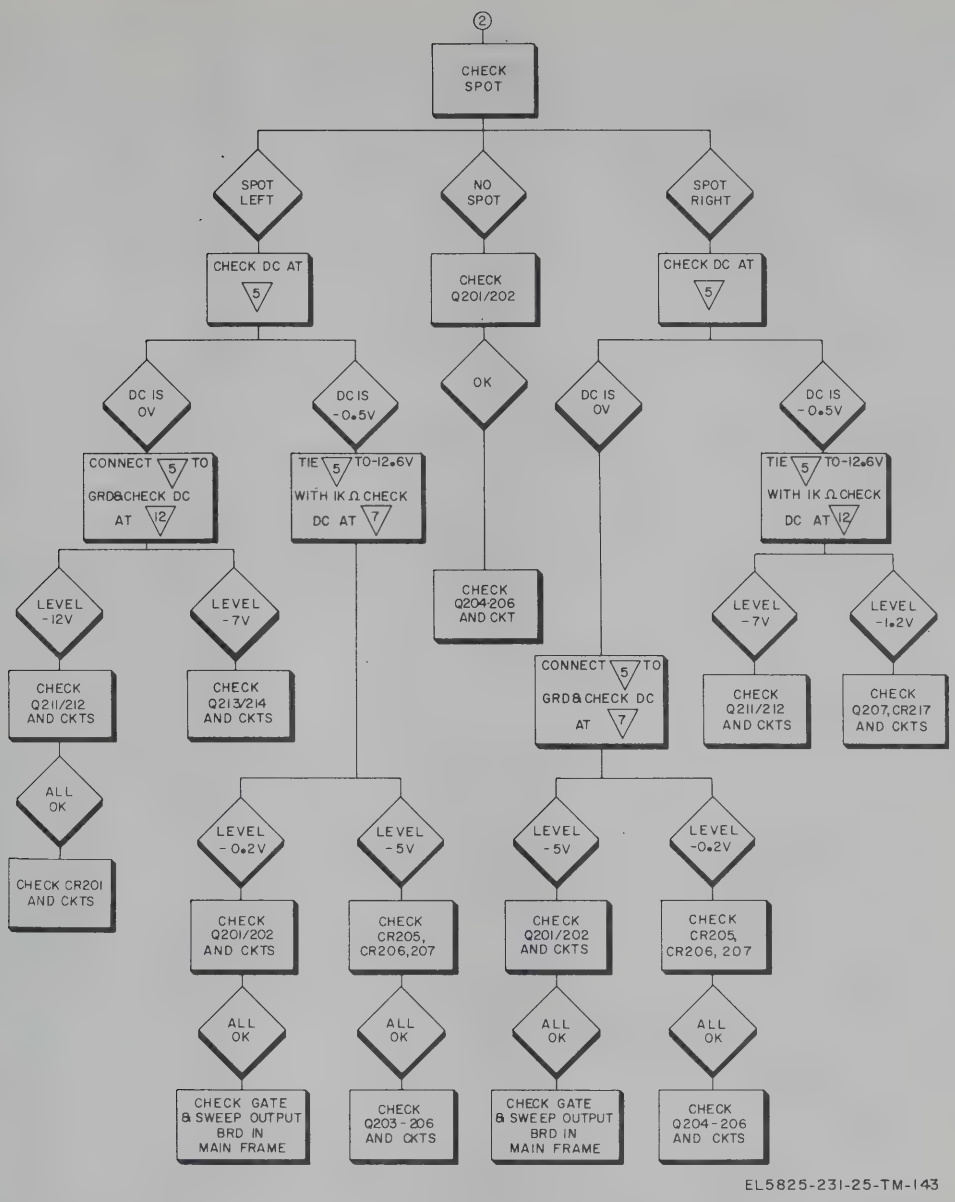


Figure 8–16. Troubleshooting flow chart, sweep generator.

(*a*) Connect a 50-MHz 0.5-volt peak-to-peak signal (as monitored at input with ac vtvm) from rf generator, to CHANNEL A INPUT and EXT INPUT.

(*b*) Adjust INTENSITY and POSITION controls to obtain a display.

(*c*) Adjust LEVEL control to obtain a stable presentation.

(*d*) Set rf generator to 90 MHz at 1-volt peak to peak (as monitored at input with ac vtvm).

(*e*) Adjust LEVEL control to obtain a stable display.

(*f*) Disconnect rf generator.

(4) *Trigger point and slope.*

(*a*) Set TIME/CM switch to 2 USEC/CM and a VOLTS/CM switch to 2.

(*b*) Connect a 40-Hz 10-volt peak-to-peak signal from audio signal generator to CHANNEL A INPUT and EXT INPUT.

(*c*) Adjust LEVEL control. Note stable display as trigger level moves smoothly along positive portion of waveform.

(*d*) Set SLOPE switch to – (negative).

(*e*) Adjust LEVEL control. Note that the display is stable as the trigger level moves smoothly along the negative portion of the waveform.

(*f*) Disconnect audio signal generator.

(5) *Sweep timing.*

(*a*) Connect OUTPUT of AN/USM-207 to CHANNEL A INPUT.

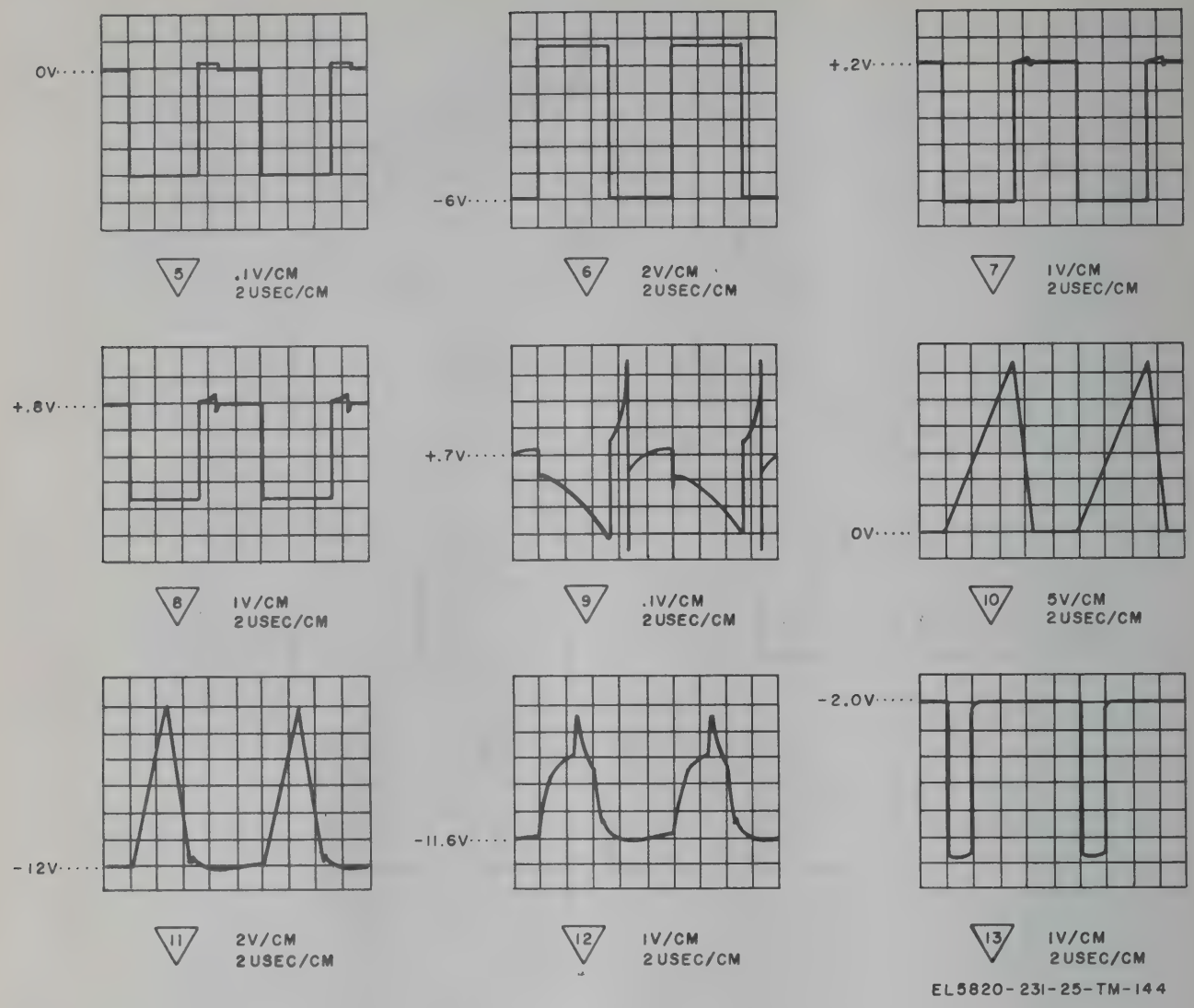


Figure 8-17. Waveforms and measurement conditions.

(*b*) Set:

TRIGGER SOURCE	INT
MODE	NORM
SLOPE	+ (positive)
CHANNEL A VOLTS/CM	0.5

(*c*) Set AN/USM-207 and TIME/CM switch according to chart 8-1. Adjust LEVEL control as necessary to obtain a stable display.

NOTE

The results of checks made in (4) and (5) above are determined by calibration accuracy of both the 1820A and the AN/USM-218(V)1.

(*d*) Adjust HORIZONTAL POSITION control to align first marker with left edge of graticule.

(*e*) The 11th or 21st marker should be within 3-mm of the right edge of the graticule.

Chart 8-1. Sweep Performance Check

AN/USM-207	*TIME/cm setting*	*Time Mark/10 cm (markers)*
50 nsec	.05 μSEC	11
0.1 μsec	0.1 μSEC	11
1 μsec	1 μSEC	11
5 μsec	5 μSEC	11
10 μsec	20 μSEC	21
0.5 msec	0.5 MSEC	11
10 msec	10 MSEC	11
1 sec	2 SEC	21

(6) *Sweep time expansion.*

(*a*) *Vernier.*

1. Set TIME/CM switch to 50 μSEC/CM and rotate VERNIER control fully ccw.

2. Set AN/USM-207 for 0.5 sec markers.

3. Any two markers should be displayed in less than 4 cm and UNCAL indicator should light.

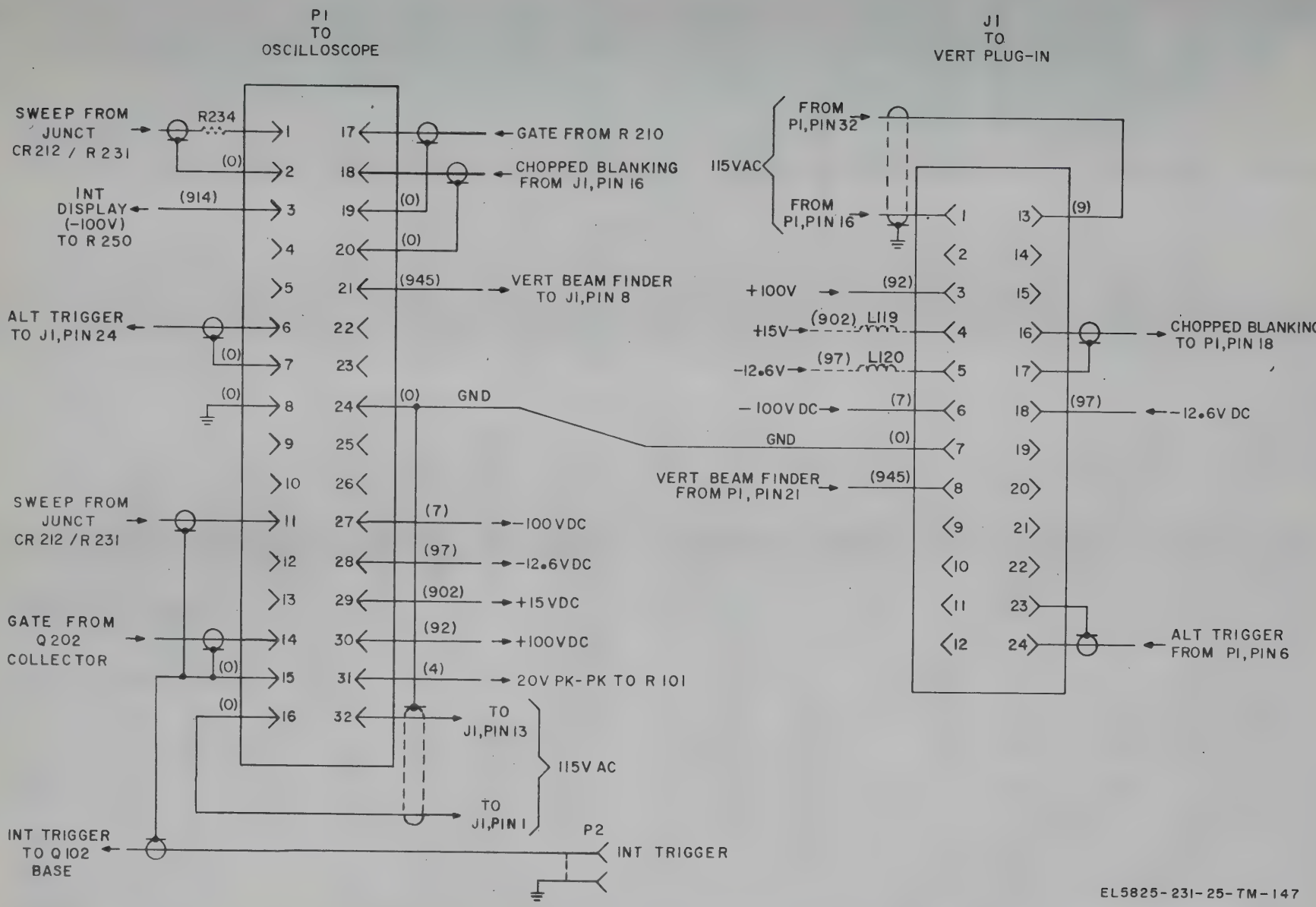


Figure 8–18. Plug connections, plug-in unit, –1820A.

(*b*) *Magnified sweep.*

1. Set TIME/CM switch to 0.05 μSEC/CM and rotate VERNIER control fully cw until UNCAL indicator extinguishes.

2. Set AN/USM–207 for 10 nsec markers and HORIZONTAL MAGNIFIER to X5.

3. Adjust HORIZONTAL POSITION control to align first marker with left edge of graticule.

4. The eleventh marker should be displayed within 5 mm of right edge of graticule.

5. Set HORIZONTAL MAGNIFIER to X10 and adjust HORIZONTAL POSITION to align first marker with left edge of graticule. Observe that the sixth marker is displayed within 5 mm of right edge of graticule.

6. Disconnect AN/USM–207.

(7) *Single sweep.*

(*a*) Set:

TIME/CM	0.1 SEC/CM
MODE	SINGLE
HORIZONTAL MAGNIFIER	X1

(*b*) Press RESET push button. The RESET indicator should light.

(*c*) Rotate LEVEL control. Only one sweep should occur. After sweep has reached right side of graticule, RESET indicator should extinguish and no more sweeps should occur.

b. Adjustments.

(1) *Preliminary.*

Lock the plug-ins together and install (see AN/USM–218(V)1) in a calibrated oscilloscope. Apply power and allow a 15-minute warmup before proceeding.

(2) *Initial control settings.*

(*a*) AN/USM–218(V)1:

HORIZONTAL MAGNIFIER	X1
HORIZONTAL DISPLAY	INT

(*b*) Vertical plug-in:

DISPLAY	A
VOLTS/CM	1

(*c*) Model 1820A time base.

VERNIER	CAL
TIME/CM	0.5 MSEC/CM
TRIGGER HOLD-OFF	NORM
TRIGGER SOURCE	INT
TRIGGER COUPLING	AC
SLOPE	+ (positive)
MODE	SINGLE

(3) *Sweep level.*

(*a*) Monitor TP204 with dc voltmeter.

(*b*) Adjust R221 for 0 vdc ±15 mv.

(4) *Sweep length.*

(*a*) Set MODE switch to AUTO and connect 100-kHz from rf generator output to CHANNEL A INPUT.

(*b*) Adjust LEVEL for shortest horizontal display.

(*c*) Adjust R232 for a 10 cm horizontal display.

(*d*) Adjust HORIZONTAL POSITION to place right side of display on the ninth graticule line and readjust R232 to increase display length 0.5 cm (this gives a total display length of 10.5 cm).

(*e*) Remove the 100 kHz signal.

(5) *Trigger hold-off.*

(*a*) Set TIME/CM to 1 MSEC.

(*b*) Connect the monitor oscilloscope through a 10:1 divider probe to TP204.

(*c*) Adjust R265 for 0.7 sec between the end of one sweep and beginning of next.

(6) *Sweep timing adjustments.*

(*a*) Set VOLTS/CM to 0.5 v/cm.

(*b*) Connect output of AN/USM–207 to CHANNEL A INPUT.

(*c*) Set the AN/USM–207 and TIME/CM switch according to chart 8–2. In each position, adjust LEVEL control to obtain a stable display.

(*d*) Adjust HORIZONTAL POSITION control to align first marker with left edge of graticule.

(*e*) The 11th and 21st marker or reference point should be within 3 mm of right edge of graticule.

Chart 8–2. Sweep Timing Adjustments

AN/USM–207	*TIME/CM*	*Time Mark/10 cm (markers)*	*Adjust*
50 nsec	.05 μSEC	11	C312
0.1 μsec	0.1 μSEC	11	C310
1 μsec	1 μSEC	11	C308
5 μsec	5 μSEC	11	C306
10 μsec	20 μSEC	21	R318
0.5 msec	0.5 MSEC	11	R317
10 msec	10 MSEC	11	R316
1 sec	2 MSEC	21	R315

D WITH MULTIMETER, SIMPSON MODEL 260
GROUND.

145VD OULD BE TAKEN.
8
SS WHICH 6.3/12.6 VAC SHOULD BE MEASURED.
25VD
2
25VDC
2
4.8VDC
1.

FRONT PANEL

V12 12AT7WA
MIXER

0VDC/0.6VAC
120
190VDC/30VAC
75K
25VDC/FIL
29K
26VDC/2.9VAC
5.2K
15VDC/32VAC
470K
2.1VDC/1.7VAC
470
25VDC/FIL
29K
25VDC/FIL
29K
240VDC/0VAC
65K

180
25V
25V
50V
4

V6 5750/68E6W
MIXER OSCILLATOR

-7VDC/30VAC
33K
-7VDC/64VAC
27K
115VDC/100VAC
85K
200VDC/100VAC
70K
0 VDC/0VAC
100
25VDC/FIL
25VDC/FIL
29K

180V
25V
25V
50V
4

V11 5750/68E6W
MIXER OSCILLATOR

-11VDC/30VAC
33K
-11VDC/26VAC
27K
115VDC/100VAC
85K
200VDC/90VAC
70K
0VDC/0VAC
100
25VDC/FIL
29K
25VDC/FIL
29K

EL5825-231-25-TM-85

FO-1. Rf detector, vr measurements.

(*b*) *Magnified sweep.*

1. Set TIME/CM switch to 0.05 μSEC/CM and rotate VERNIER control fully cw until UNCAL indicator extinguishes.

2. Set AN/USM-207 for 10 nsec markers and HORIZONTAL MAGNIFIER to X5.

3. Adjust HORIZONTAL POSITION control to align first marker with left edge of graticule.

4. The eleventh marker should be displayed within 5 mm of right edge of graticule.

5. Set HORIZONTAL MAGNIFIER to X10 and adjust HORIZONTAL POSITION to align first marker with left edge of graticule. Observe that the sixth marker is displayed within 5 mm of right edge of graticule.

6. Disconnect AN/USM-207.

(7) *Single sweep.*

(*a*) Set:

TIME/CM ..... 0.1 SEC/CM
MODE ..... SINGLE
HORIZONTAL MAGNIFIER X1

(*b*) Press RESET push button. The RESET indicator should light.

(*c*) Rotate LEVEL control. Only one sweep should occur. After sweep has reached right side of graticule, RESET indicator should extinguish and no more sweeps should occur.

b. Adjustments.

(1) *Preliminary.*

Lock the plug-ins together and install (see AN/USM-218(V)1) in a calibrated oscilloscope. Apply power and allow a 15-minute warmup before proceeding.

(2) *Initial control settings.*

(*a*) AN/USM-218(V)1:

HORIZONTAL MAGNIFIER X1
HORIZONTAL DISPLAY ..... INT

(*b*) Vertical plug-in:

DISPLAY ..... A
VOLTS/CM 1

(*c*) Model 1820A time base.

VERNIER ..... CAL
TIME/CM ..... 0.5 MSEC/CM
TRIGGER HOLD-OFF ..... NORM
TRIGGER SOURCE ..... INT
TRIGGER COUPLING ..... AC
SLOPE ..... + (positive)
MODE ..... SINGLE

(3) *Sweep level.*

(*a*) Monitor TP204 with dc voltmeter.

(*b*) Adjust R221 for 0 vdc ±15 mv.

(4) *Sweep length.*

(*a*) Set MODE switch to AUTO and connect 100-kHz from rf generator output to CHANNEL A INPUT.

(*b*) Adjust LEVEL for shortest horizontal display.

(*c*) Adjust R232 for a 10 cm horizontal display.

(*d*) Adjust HORIZONTAL POSITION to place right side of display on the ninth graticule line and readjust R232 to increase display length 0.5 cm (this gives a total display length of 10.5 cm).

(*e*) Remove the 100 kHz signal.

(5) *Trigger hold-off.*

(*a*) Set TIME/CM to 1 MSEC.

(*b*) Connect the monitor oscilloscope through a 10:1 divider probe to TP204.

(*c*) Adjust R265 for 0.7 sec between the end of one sweep and beginning of next.

(6) *Sweep timing adjustments.*

(*a*) Set VOLTS/CM to 0.5 v/cm.

(*b*) Connect output of AN/USM-207 to CHANNEL A INPUT.

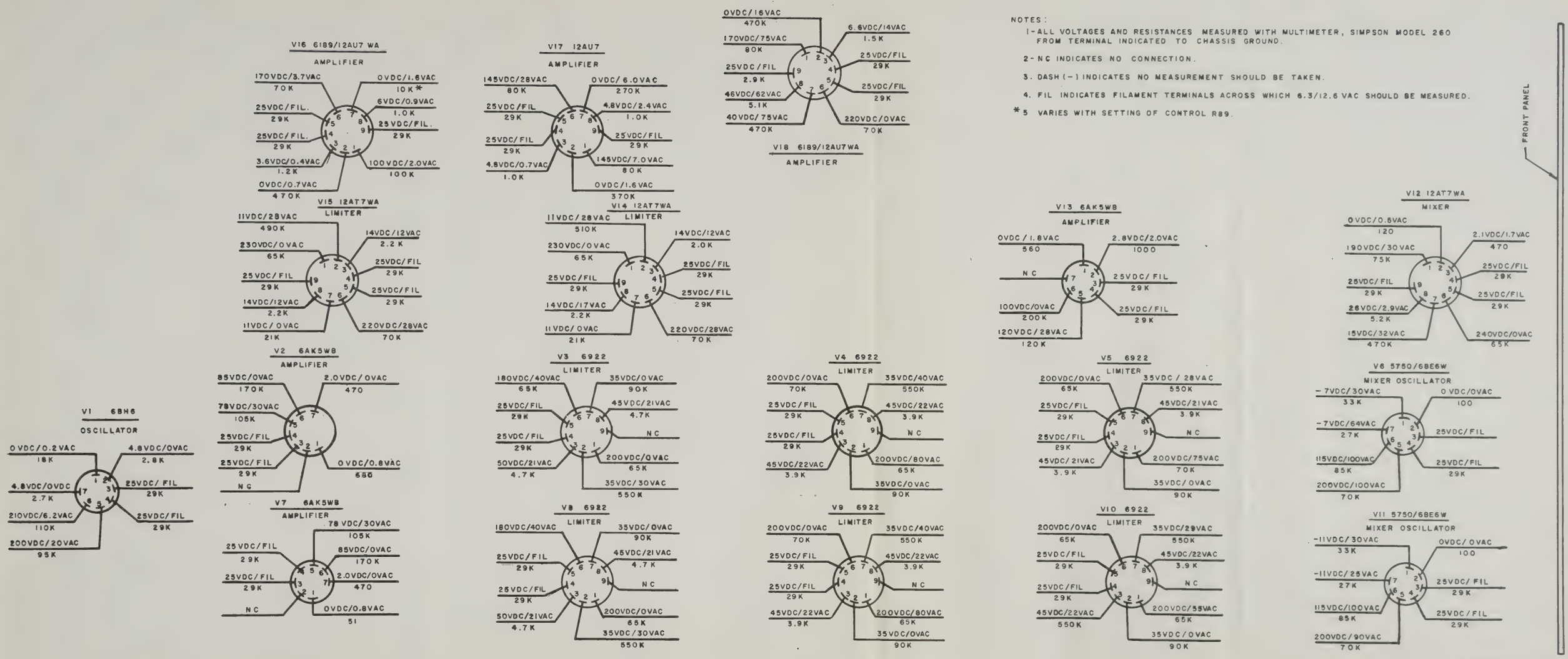
(*c*) Set the AN/USM-207 and TIME/CM switch according to chart 8-2. In each position, adjust LEVEL control to obtain a stable display.

(*d*) Adjust HORIZONTAL POSITION control to align first marker with left edge of graticule.

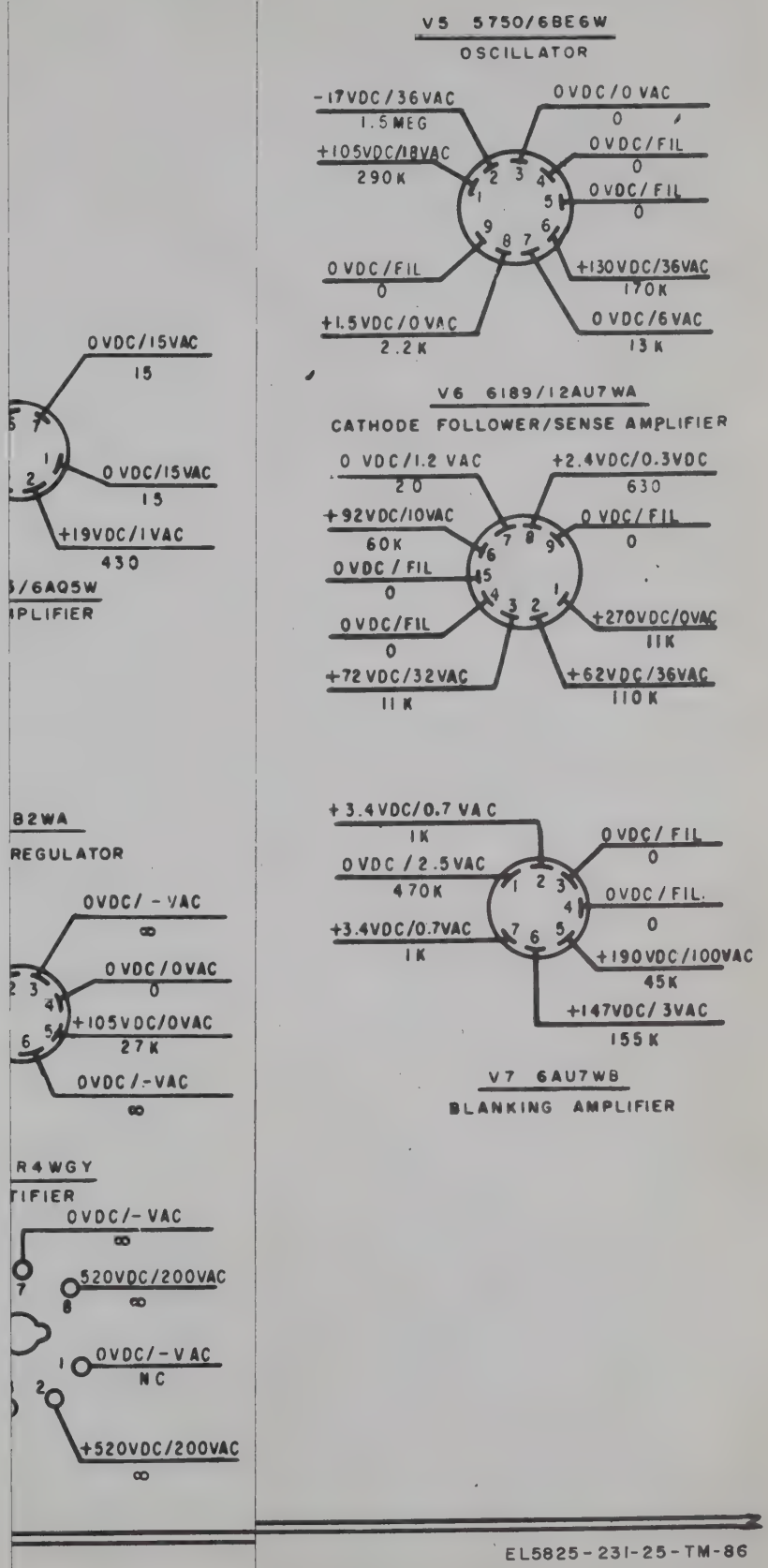
(*e*) The 11th and 21st marker or reference point should be within 3 mm of right edge of graticule.

Chart 8-2. Sweep Timing Adjustments

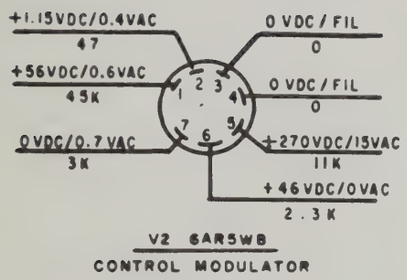
AN/USM-207	*TIME/CM*	*Time Mark/10 cm (markers)*	*Adjust*
50 nsec	.05 μSEC	11	C312
0.1 μsec	0.1 μSEC	11	C310
1 μsec	1 μSEC	11	C308
5 μsec	5 μSEC	11	C306
10 μsec	20 μSEC	21	R318
0.5 msec	0.5 MSEC	11	R317
10 msec	10 MSEC	11	R316
1 sec	2 MSEC	21	R315



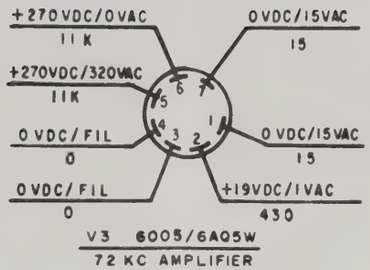
FO-1. Rf detector, vr measurements.



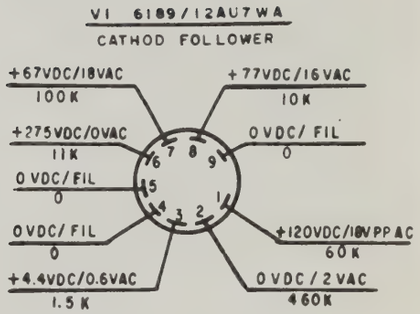
FO-2. Azimuth indicator, vr measurements.



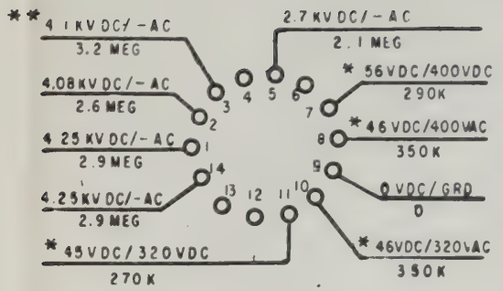
V2 6AR5WB
CONTROL MODULATOR



V3 6005/6AQ5W
72 KC AMPLIFIER



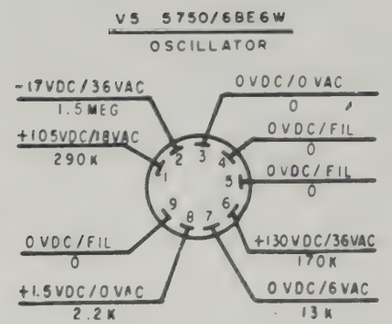
V1 6189/12AU7WA
CATHOD FOLLOWER



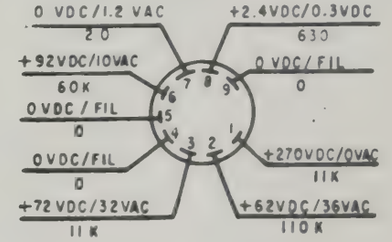
V4 7E23P7M
INDICATOR CR TUBE

NOTES:

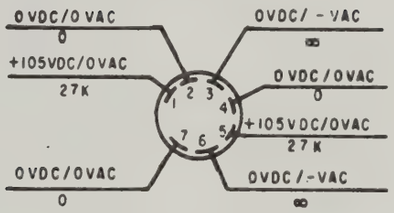
1. ALL VOLTAGES AND RESISTANCES MEASURED WITH MULTIMETER, SIMPSOM MODEL 260 FROM TERMINAL INDICATED TO CHASIS GROUND.
2. NC INDICATES NO CONNECTION.
3. DASH(—) INDICATES NO MEASURMENT SHOULD BE TAKEN.
4. FIL INDICATES FILAMENT TERMINALS ACROSS WHICH 6.3 VAC SHOULD BE MEASURED.
5. * VARIES WITH CENTERING CONTROL
6. ** VARIES WITH INTENSITY.



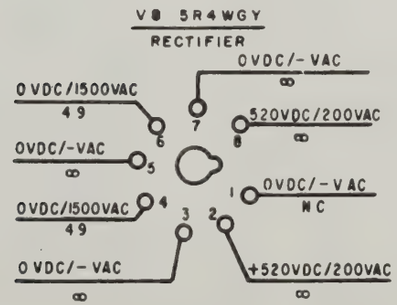
V5 5750/6BE6W
OSCILLATOR



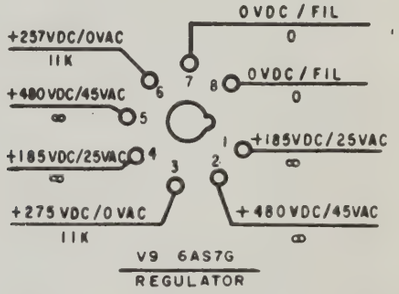
V6 6189/12AU7WA
CATHODE FOLLOWER/SENSE AMPLIFIER



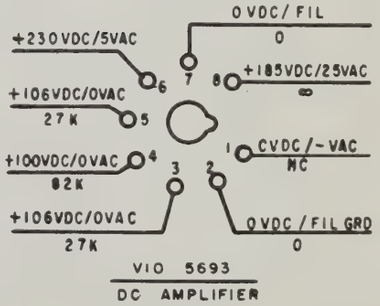
VII 0B2WA
VOLTAGE REGULATOR



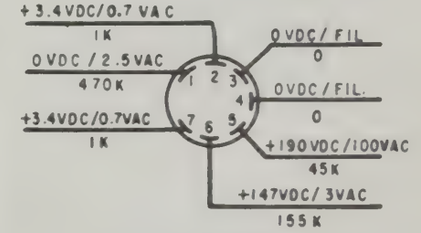
V8 5R4WGY
RECTIFIER



V9 6AS7G
REGULATOR



V10 5693
DC AMPLIFIER

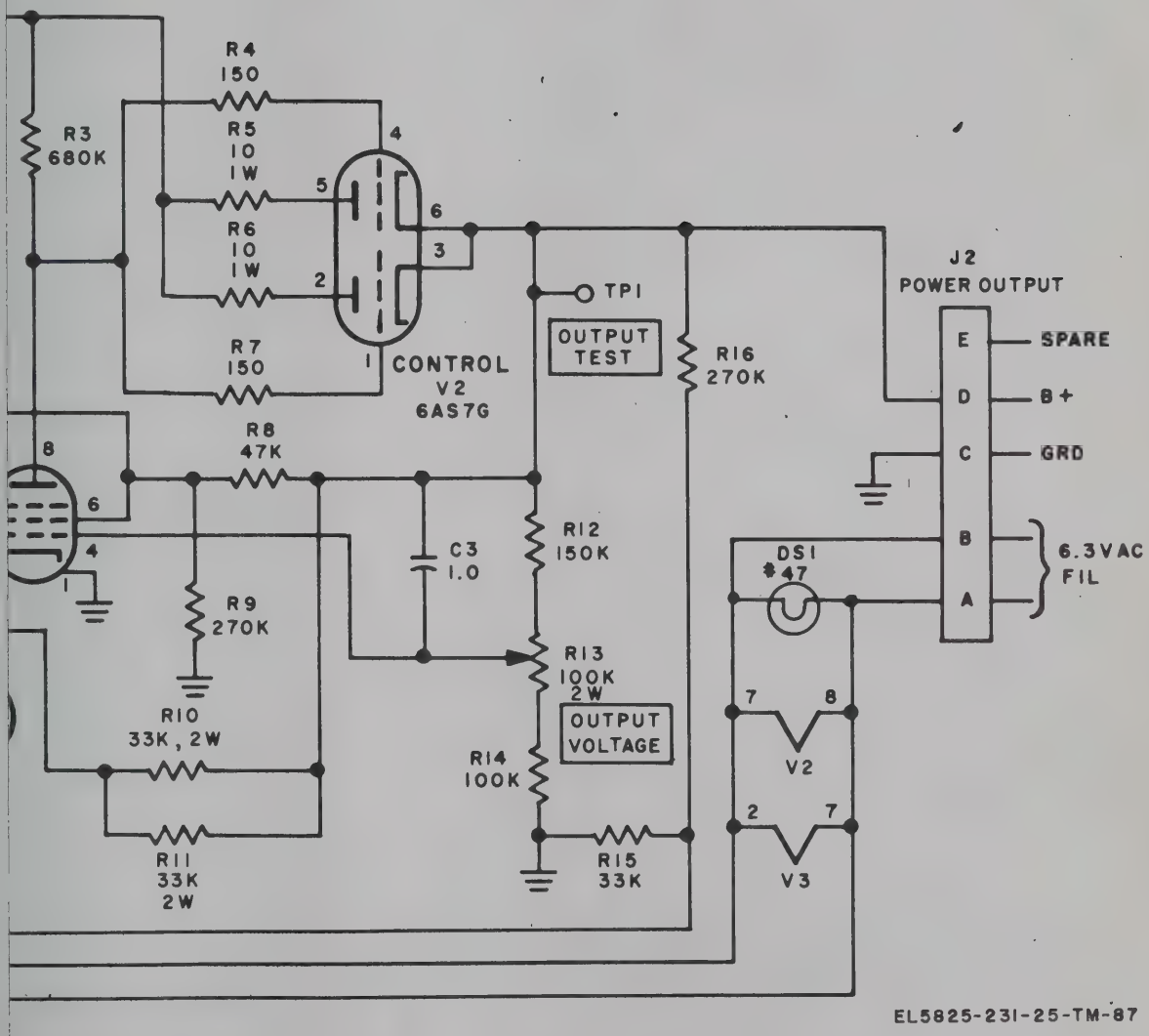


V7 6AU7WB
BLANKING AMPLIFIER

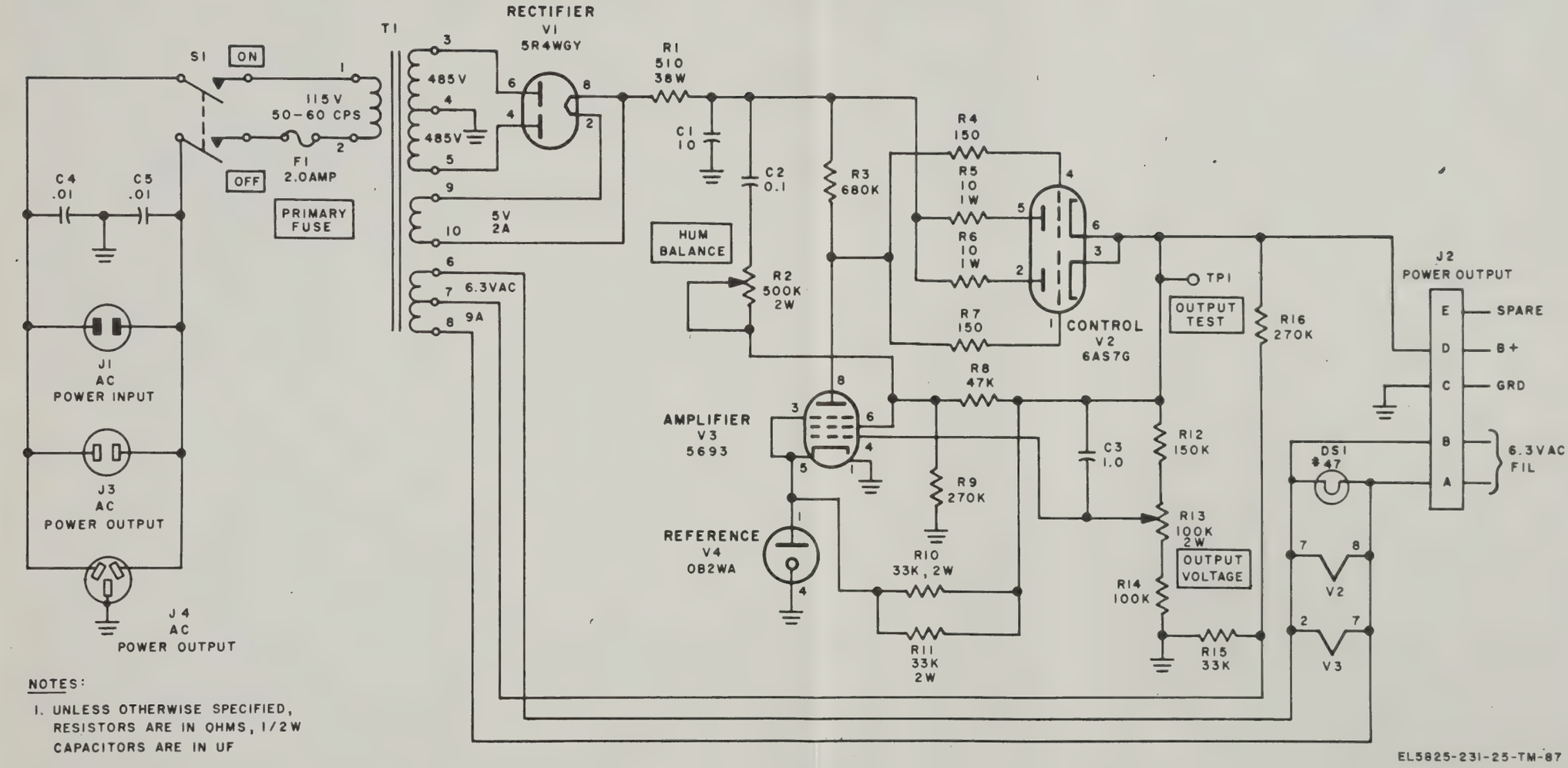
FRONT PANEL

EL5825-231-25-TM-86

FO-2. Azimuth indicator, vr measurements.



FO–3. Power supply, schematic diagram.

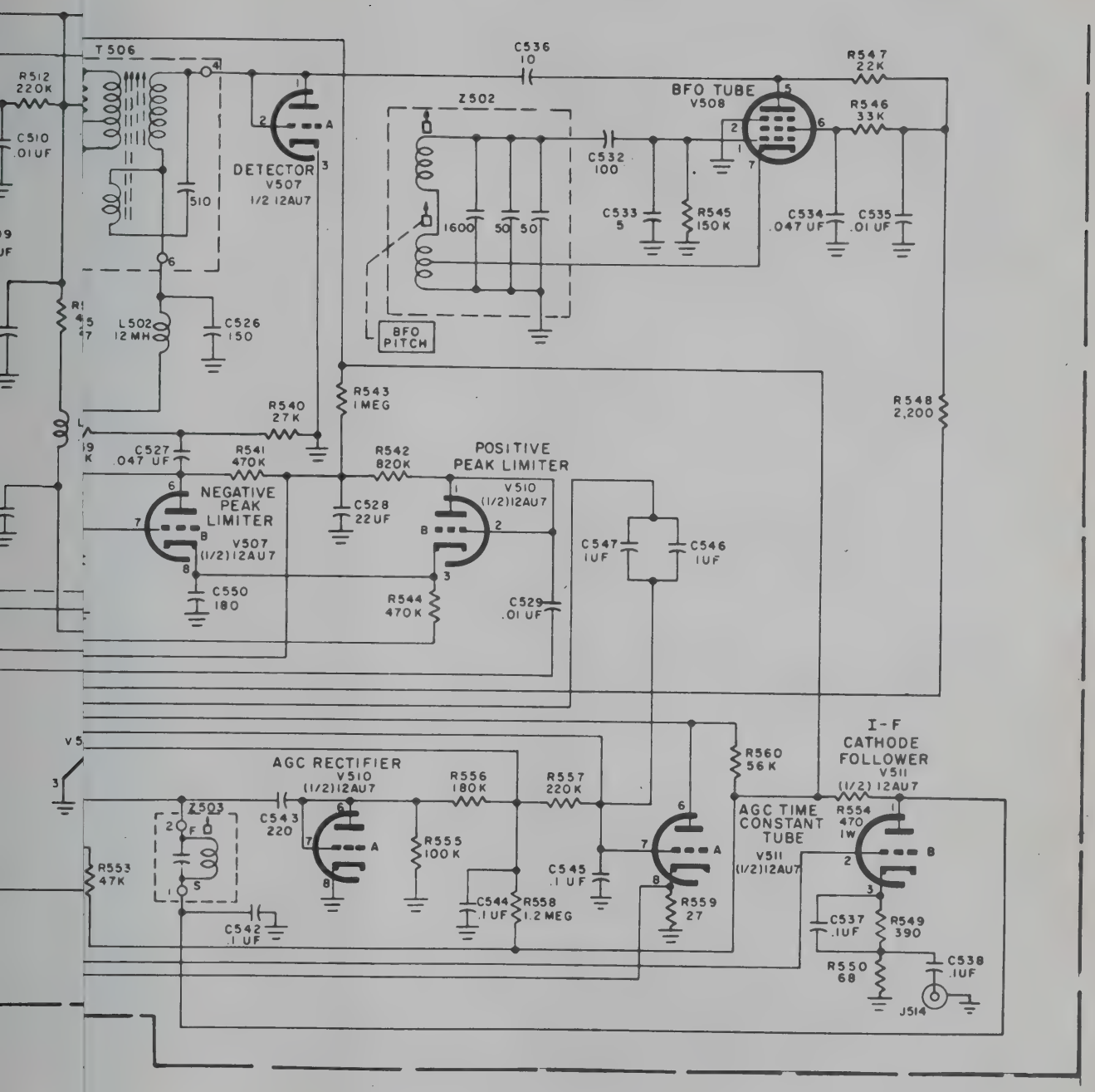


NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, 1/2W CAPACITORS ARE IN UF

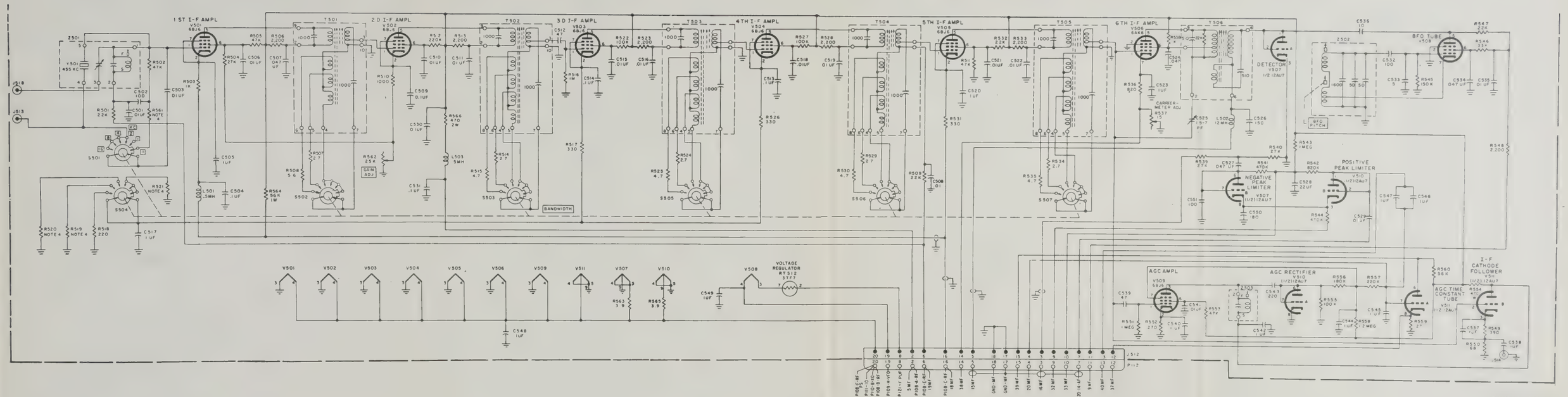
EL5825-231-25-TM-87

FO-3. Power supply, schematic diagram.

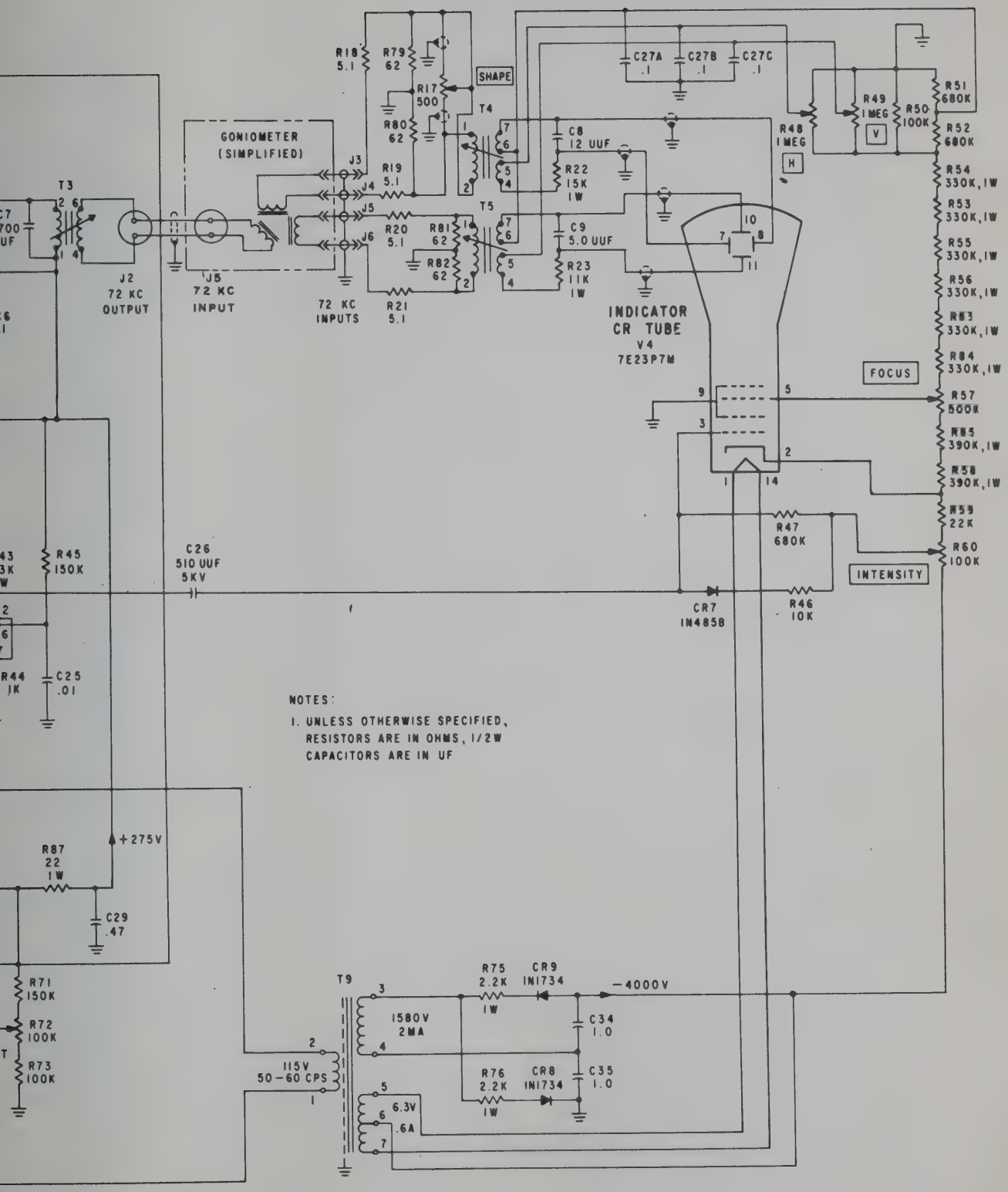


EL5825-231-25-TM-88

FO-4. If. subchassis, schematic diagram.



FO-4. *If. subchassis, schematic diagram.*



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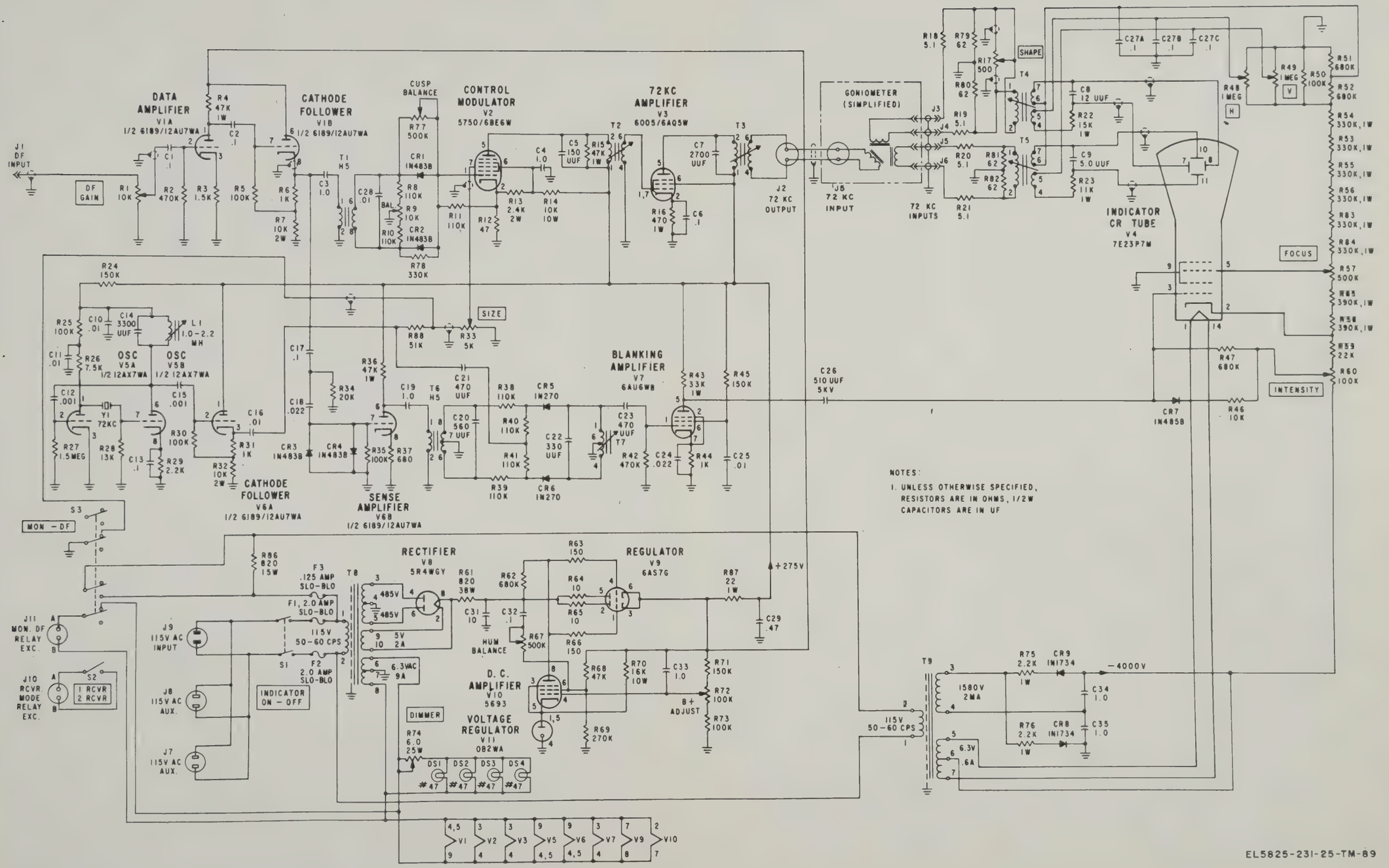
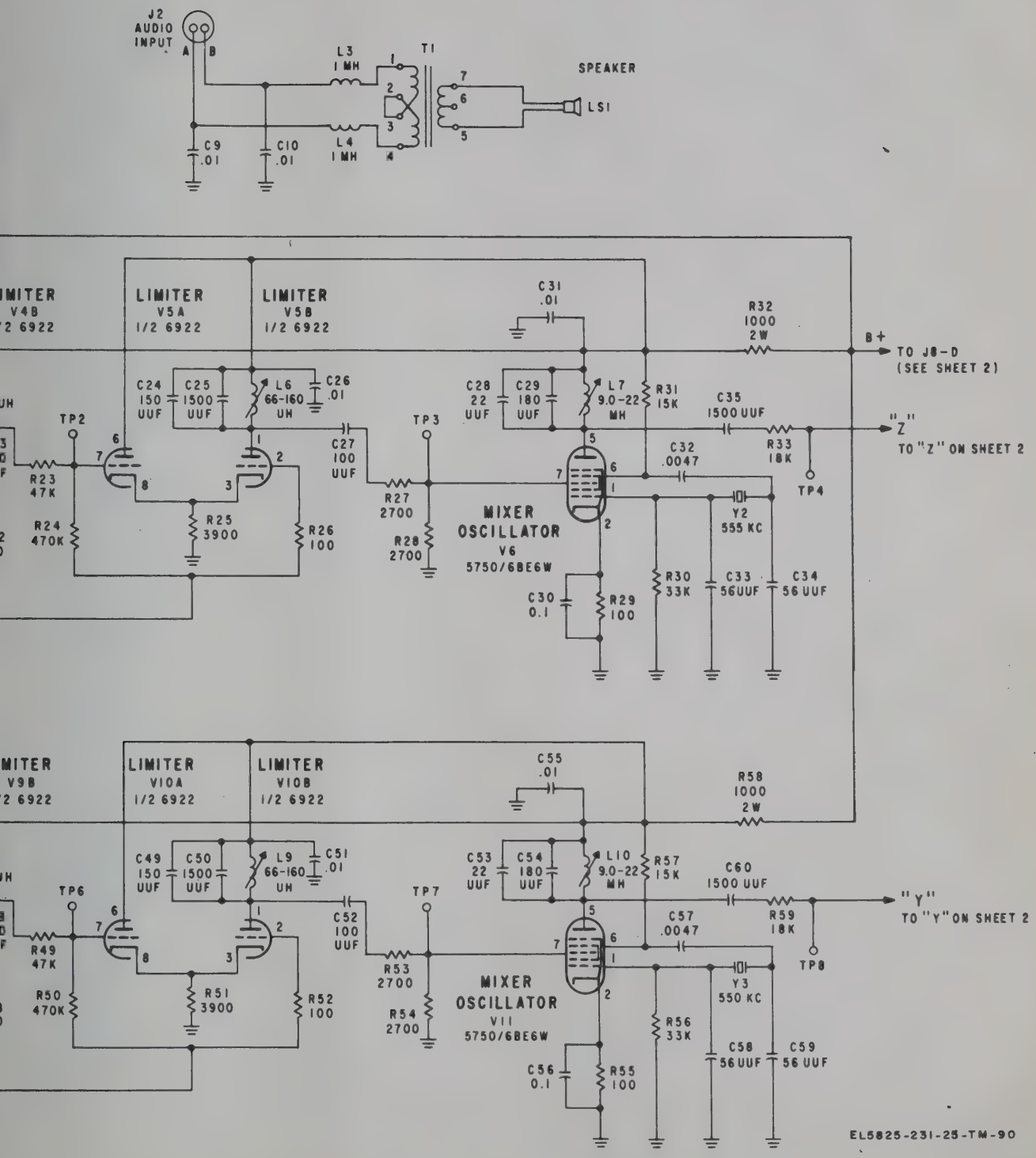
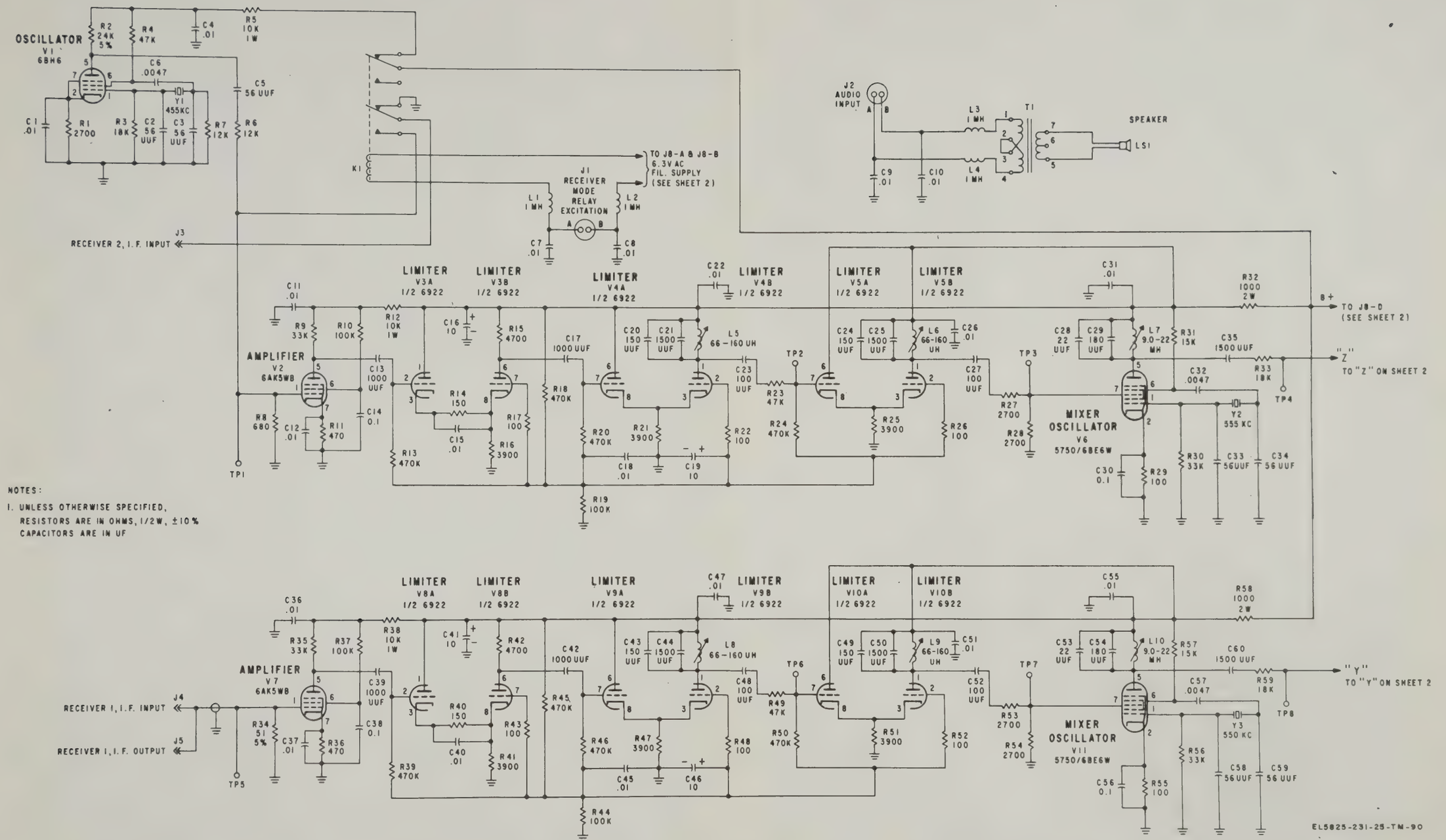
FO-5. Azimuth indicator, schematic diagram.



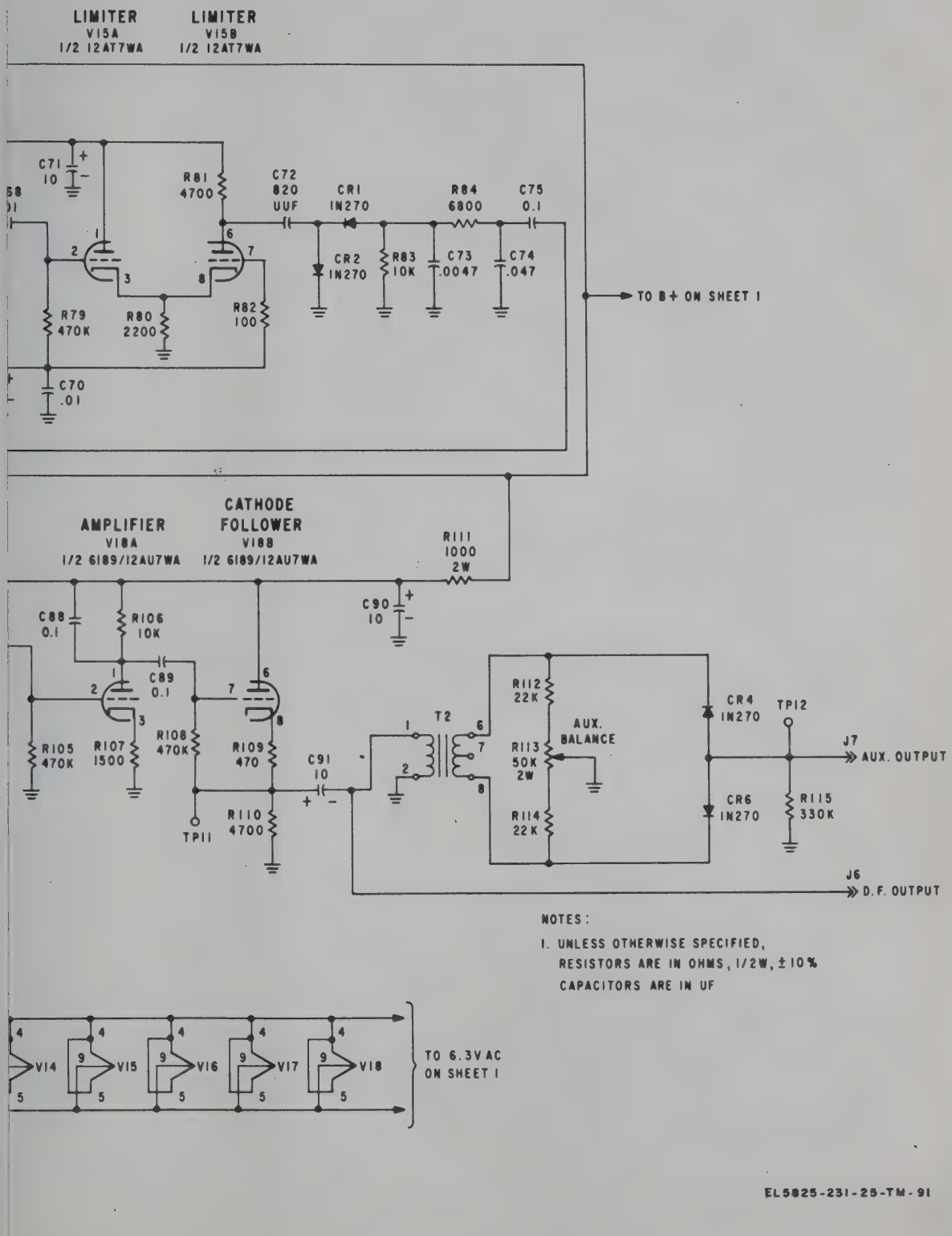
FO-5. Azimuth indicator, schematic diagram.



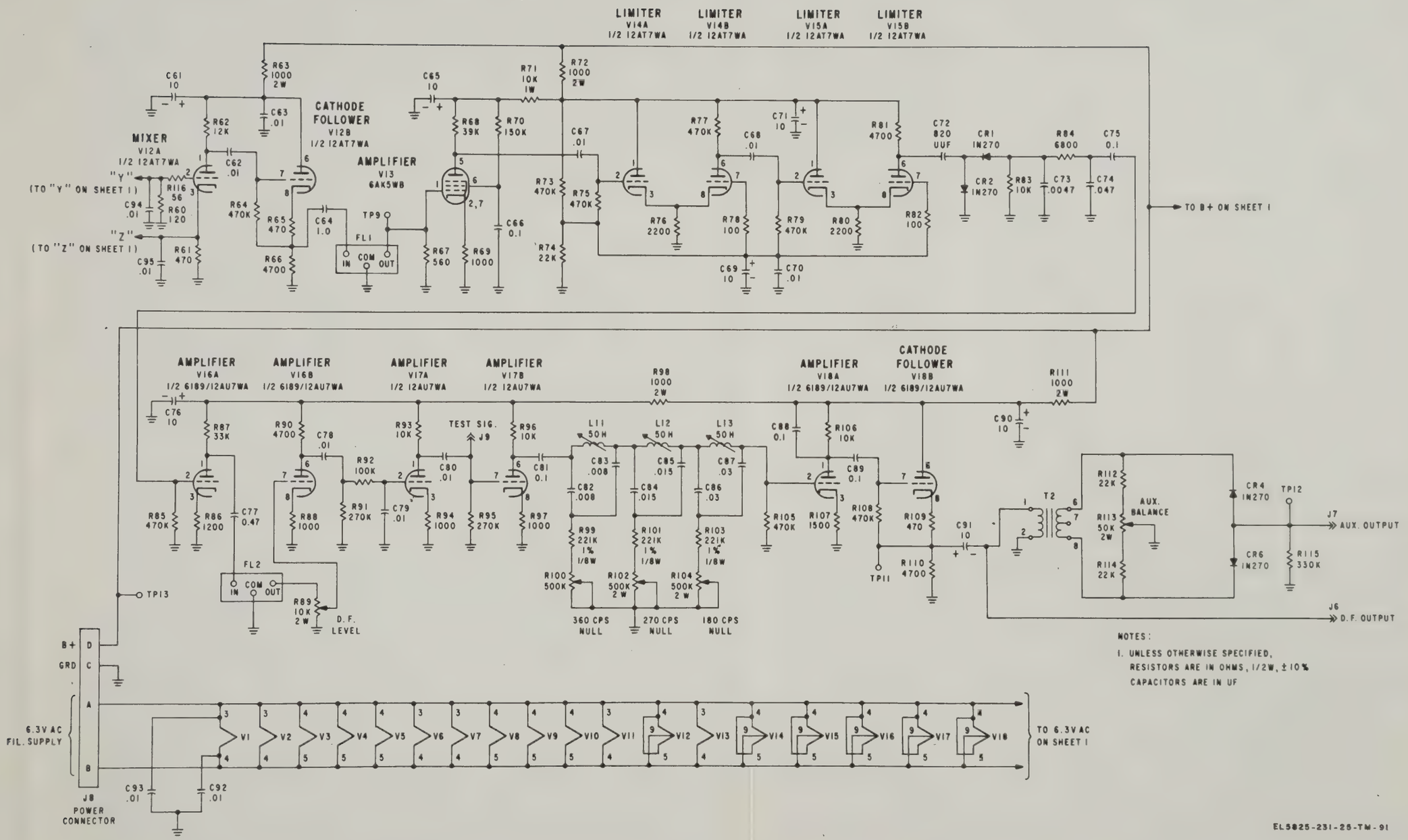
FO-6. Radiofrequency Detector RF-159-(*)/TRD, schematic diagram (sheet 1 of 3).



FO-6. Radiofrequency Detector RF-159-(*)/TRD, schematic diagram (sheet 1 of 3).



FO-7. Radiofrequency Detector RF-159-(*)/TRD, schematic diagram (sheet 2 of 3).



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, 1/2W, ±10% CAPACITORS ARE IN UF

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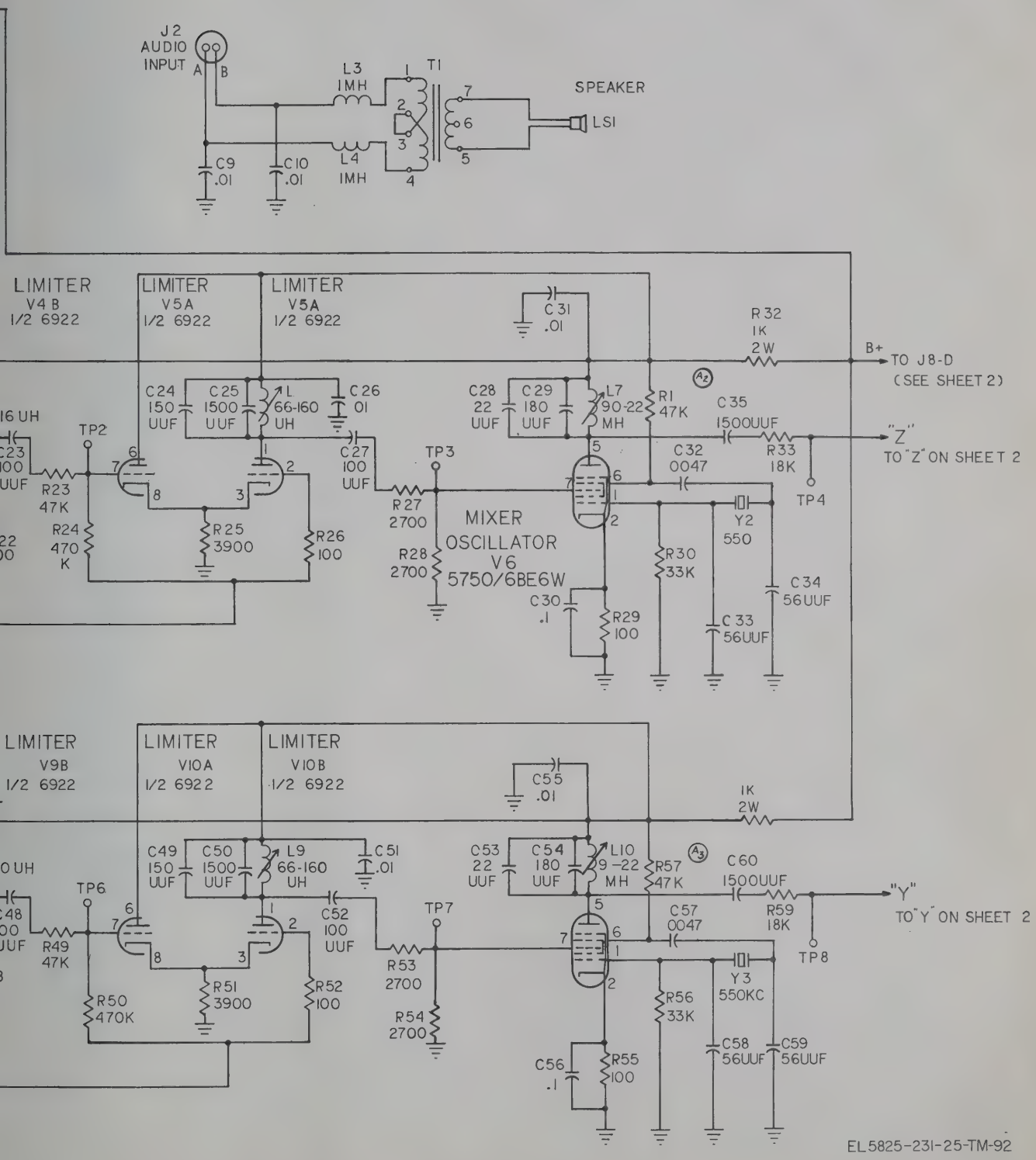
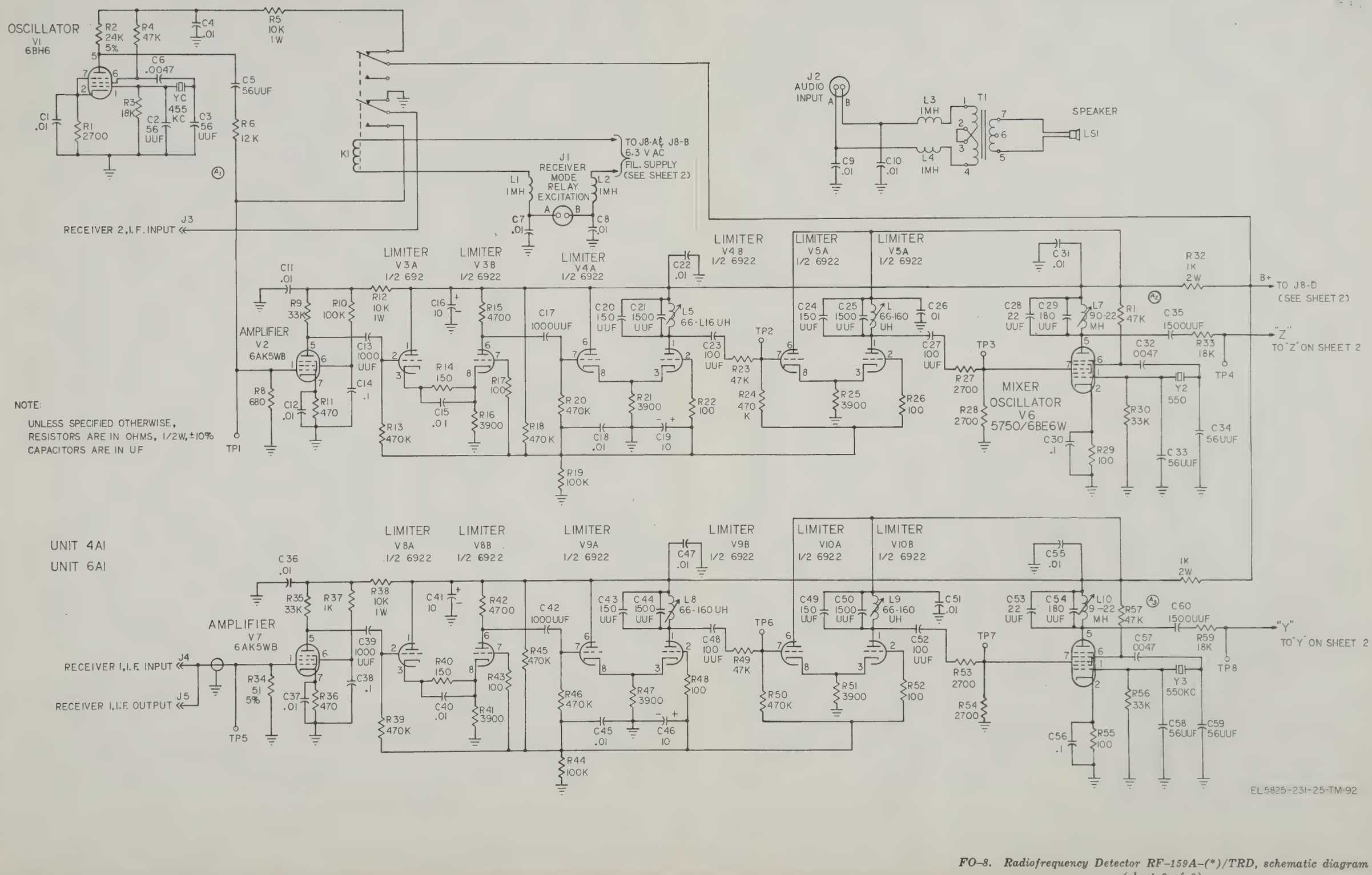
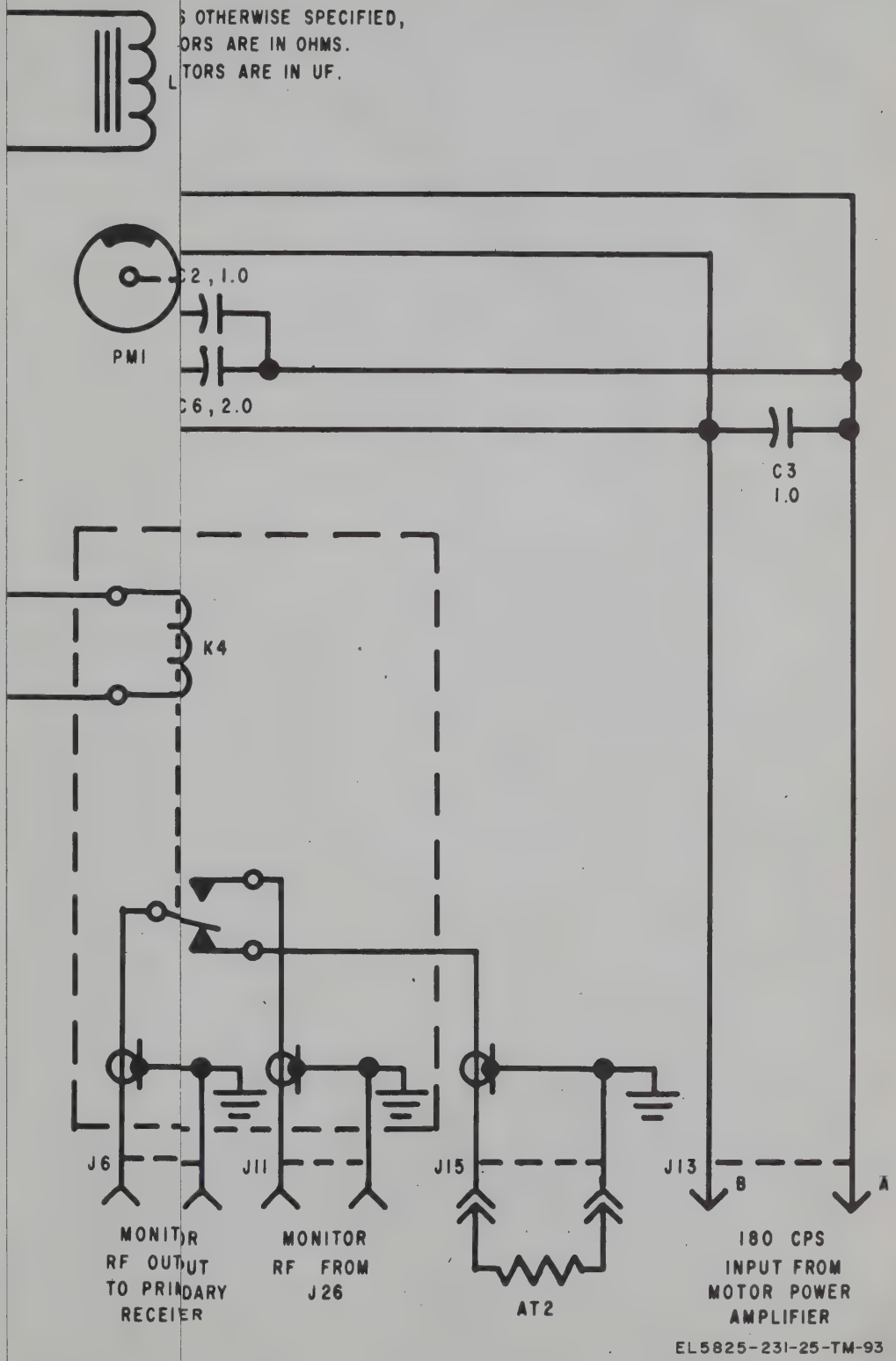
FO-7. Radiofrequency Detector RF-159-(*)/TRD, schematic diagram (sheet 2 of 3).



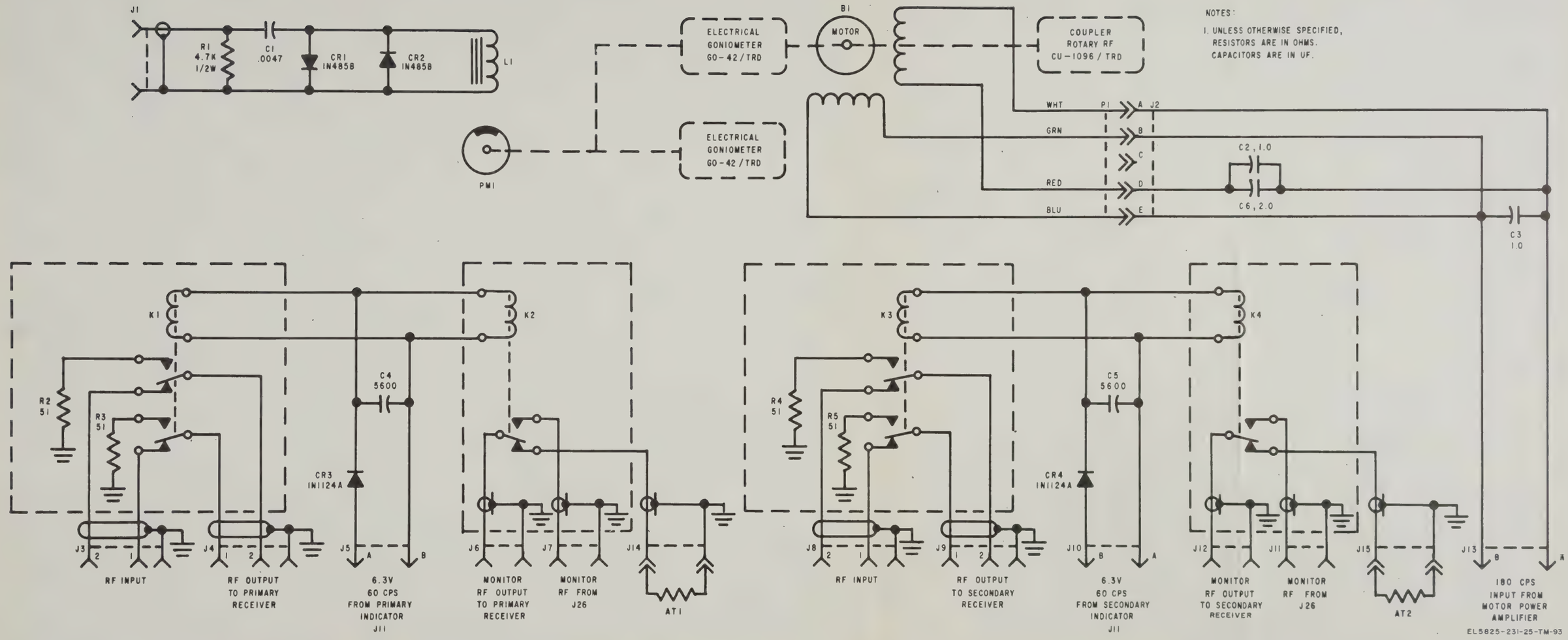
FO–8. Radiofrequency Detector RF–159A–(*)/TRD, schematic diagram (sheet 3 of 3).



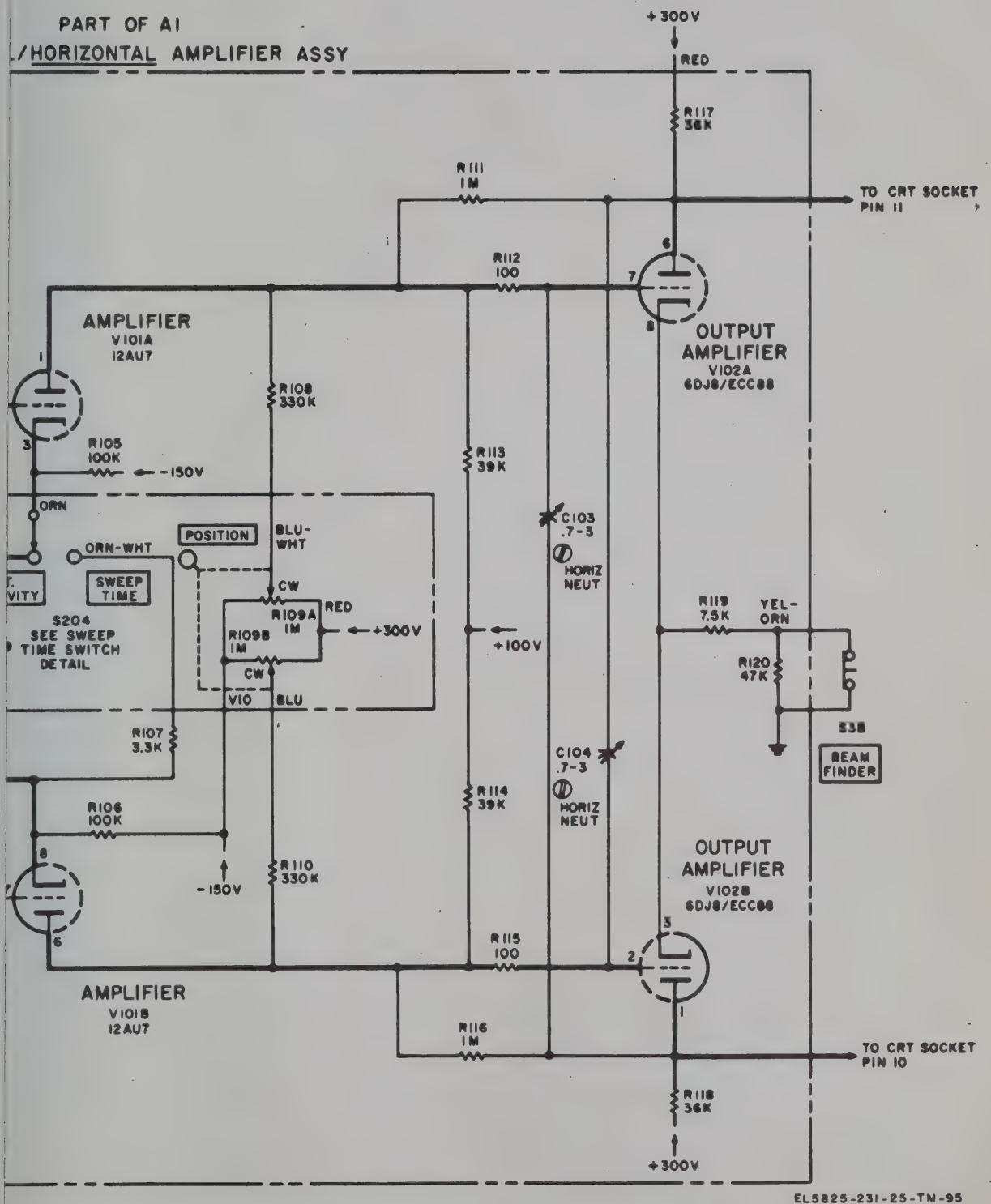
FO–8. Radiofrequency Detector RF–159A–(*)/TRD, schematic diagram (sheet 3 of 3).



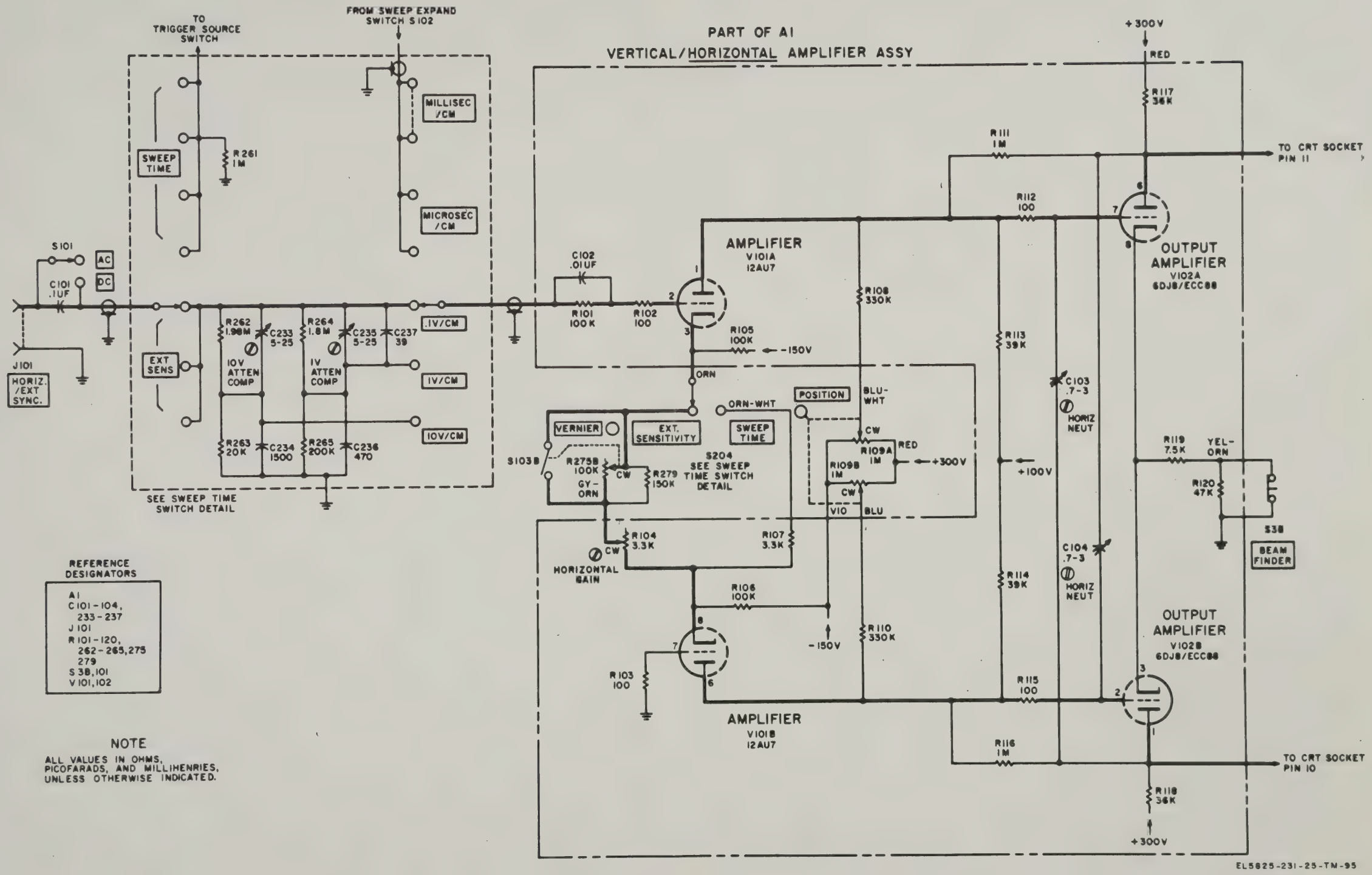
FO–9. Drive, goniometer-rotary coupler, schematic.



FO-9. Drive, goniometer-rotary coupler, schematic.



FO–10. Monitor oscilloscope 120B, schematic diagram, horizontal amplifier.



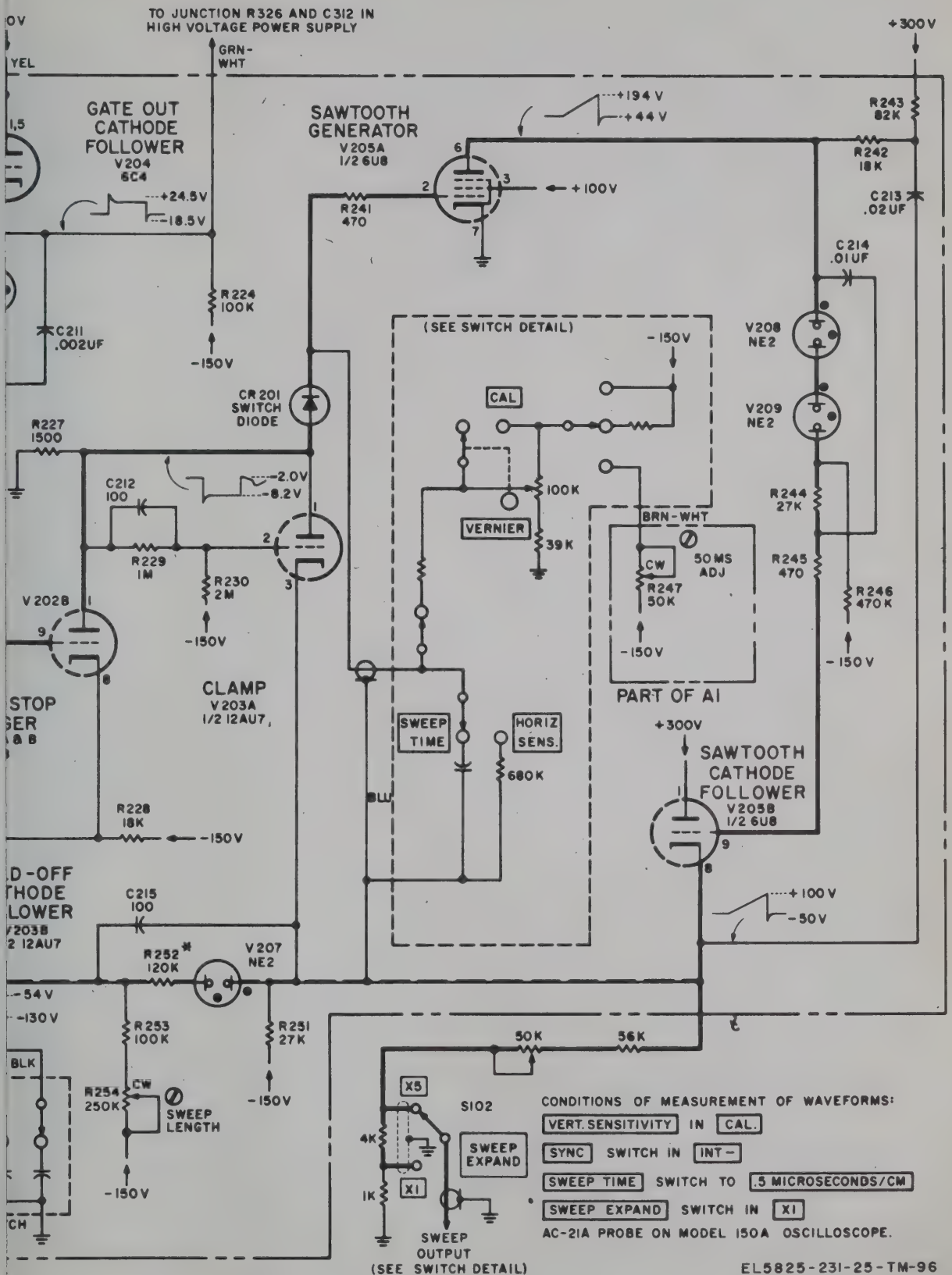
REFERENCE DESIGNATORS

A1
C101-104, 233-237
J101
R101-120, 262-265, 275 279
S38, 101
V101, 102

NOTE

ALL VALUES IN OHMS, PICOFARADS, AND MILLIHENRIES, UNLESS OTHERWISE INDICATED.

FO-10. Monitor oscilloscope 120B, schematic diagram, horizontal amplifier.



FO–11. Monitor oscilloscope 120B, schematic diagram, sweep generator.

PART OF A202
SWEEP GENERATOR AND LOW VOLTAGE POWER SUPPLY ASSY.
(1208-658)

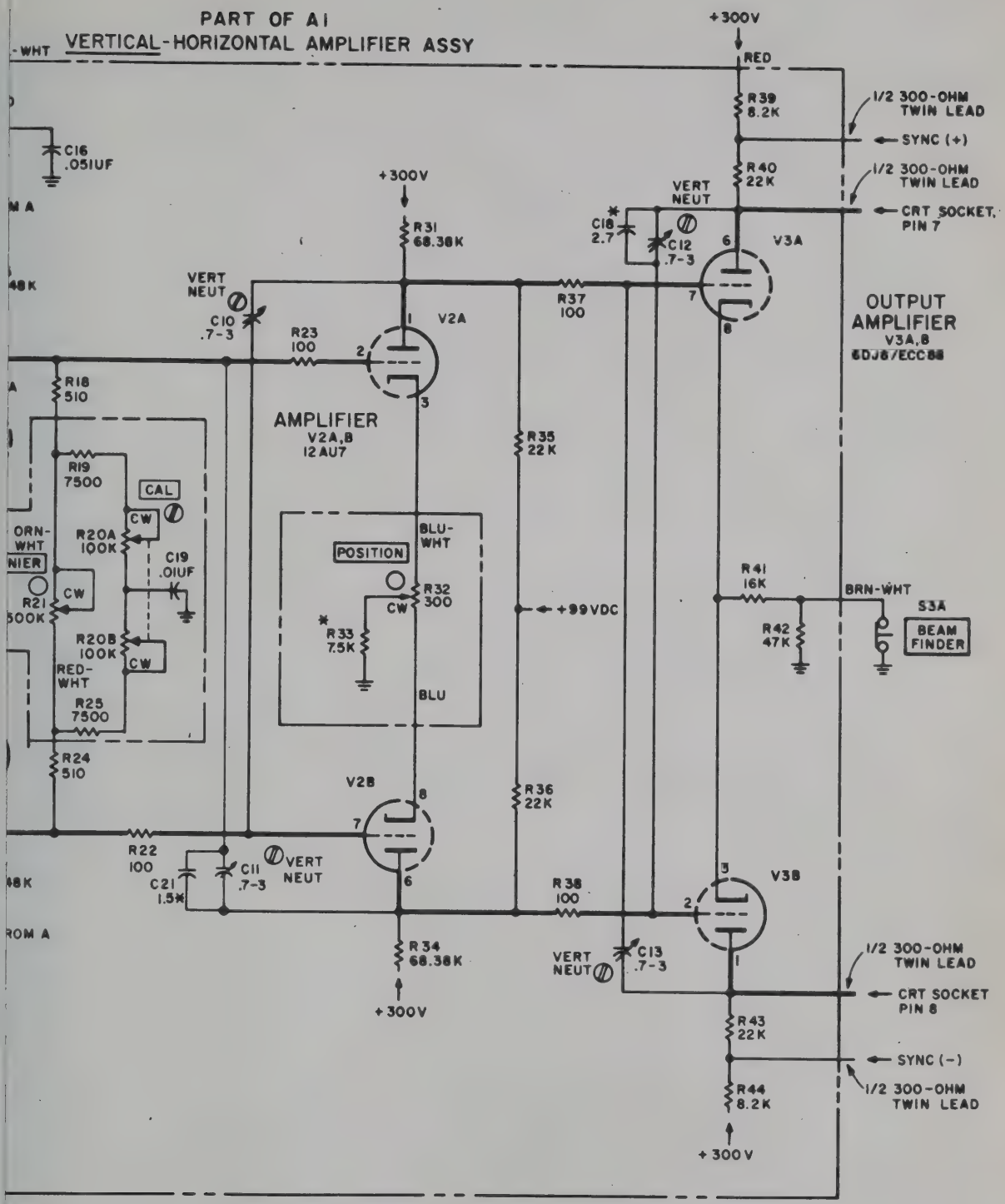
NOTE
1. ALL VALUES IN OHMS, PICOFARADS AND MILLIHENRIES UNLESS OTHERWISE NOTED

REFERENCE DESIGNATORS
A 202
C 201 - 216
CR 201
L 201
R 201 - 259
S 102, 201
V 201 - 209

UNASSIGNED:
C 210
R 217 - 220, 231 - 240, 248 - 250, 255

FROM HORIZ. SENS. S.W.
6.3 VAC FROM T302
FROM VERT. AMP. 300 OHM TWIN LEAD
EXT
LINE
INT-
INT+
GY
GRN
C201 1.5
S201
TRIGGER SOURCE
C202 .02UF
R202 1.8M
R201 100
47V
V201A
V201B
TRIGGER GENERATOR
V201A & B
6DJ8/ECC88
TRIGGER SENSITIVITY
R203 1000
CW
R204 1.5K
C203 12
R206 83K
C204 1.5
R208 3900
C207 47
C208 68
6-9V
L201 500 UH
R210 3900
R216 225
C209 1500
*R207 18K
R211 71.56K
R205 24K
C205 40UF
C206 40UF
R209 24K
AUTO
S202
-150V
-73V
-63V
+22.5V
-22.5V
+100V
YEL
TO JUNCTION R326 AND C312 IN HIGH VOLTAGE POWER SUPPLY
GRN-WHT
R221 68K
R222 100
R223 24K
GATE OUT CATHODE FOLLOWER
V204
6C4
+24.5V
-18.5V
V206 NE2
C211 .002UF
R224 100K
R225 27K
R226 680K
R227 1500
CR201 SWITCH DIODE
C212 100
R229 1M
R230 2M
-2.0V
-8.2V
V202B
V202A
START-STOP TRIGGER
V202A & B
6U8
CLAMP
V203A
1/2 12AU7
R228 18K
R255 10K
HOLD-OFF CATHODE FOLLOWER
V203B
1/2 12AU7
C215 100
R252* 120K
V207 NE2
-54V
-130V
R253 100K
R254 250K
CW
SWEEP LENGTH
R251 27K
R256 430K
R257 24K
R258 20K
PRESET
R259 27K
C216 .01 UF
-150 V
V10
WHT
BLK
(SEE SWITCH DETAIL)
SAWTOOTH GENERATOR
V205A
1/2 6U8
+194 V
+44 V
+100V
R241 470
R242 18K
R243 82K
C213 .02UF
C214 .01UF
V208 NE2
V209 NE2
R244 27K
R245 470
R246 470K
+300V
(SEE SWITCH DETAIL)
CAL
VERNIER
100K
39K
BRN-WHT
CW
50MS ADJ
R247 50K
PART OF A1
SWEEP TIME
HORIZ SENS.
680K
BLU
SAWTOOTH CATHODE FOLLOWER
V205B
1/2 6U8
+100 V
-50V
50K
56K
S102
X5
X1
4K
1K
SWEEP EXPAND
SWEEP OUTPUT
(SEE SWITCH DETAIL)
CONDITIONS OF MEASUREMENT OF WAVEFORMS:
VERT. SENSITIVITY IN CAL.
SYNC SWITCH IN INT-
SWEEP TIME SWITCH TO .5 MICROSECONDS/CM
SWEEP EXPAND SWITCH IN X1
AC-21A PROBE ON MODEL 150A OSCILLOSCOPE.
EL5825-231-25-TM-96

FO-11. Monitor oscilloscope 120B, schematic diagram, sweep generator.



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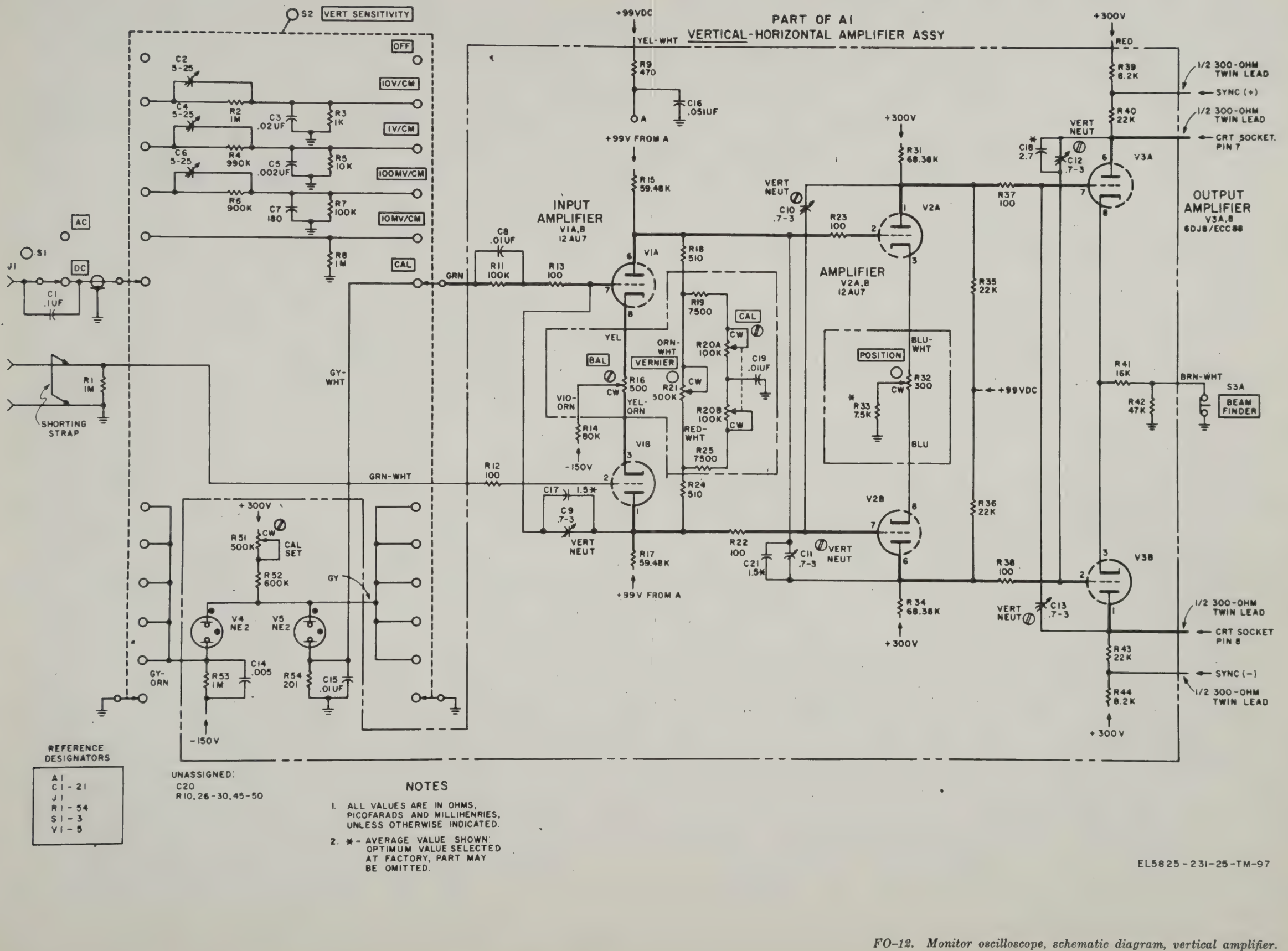
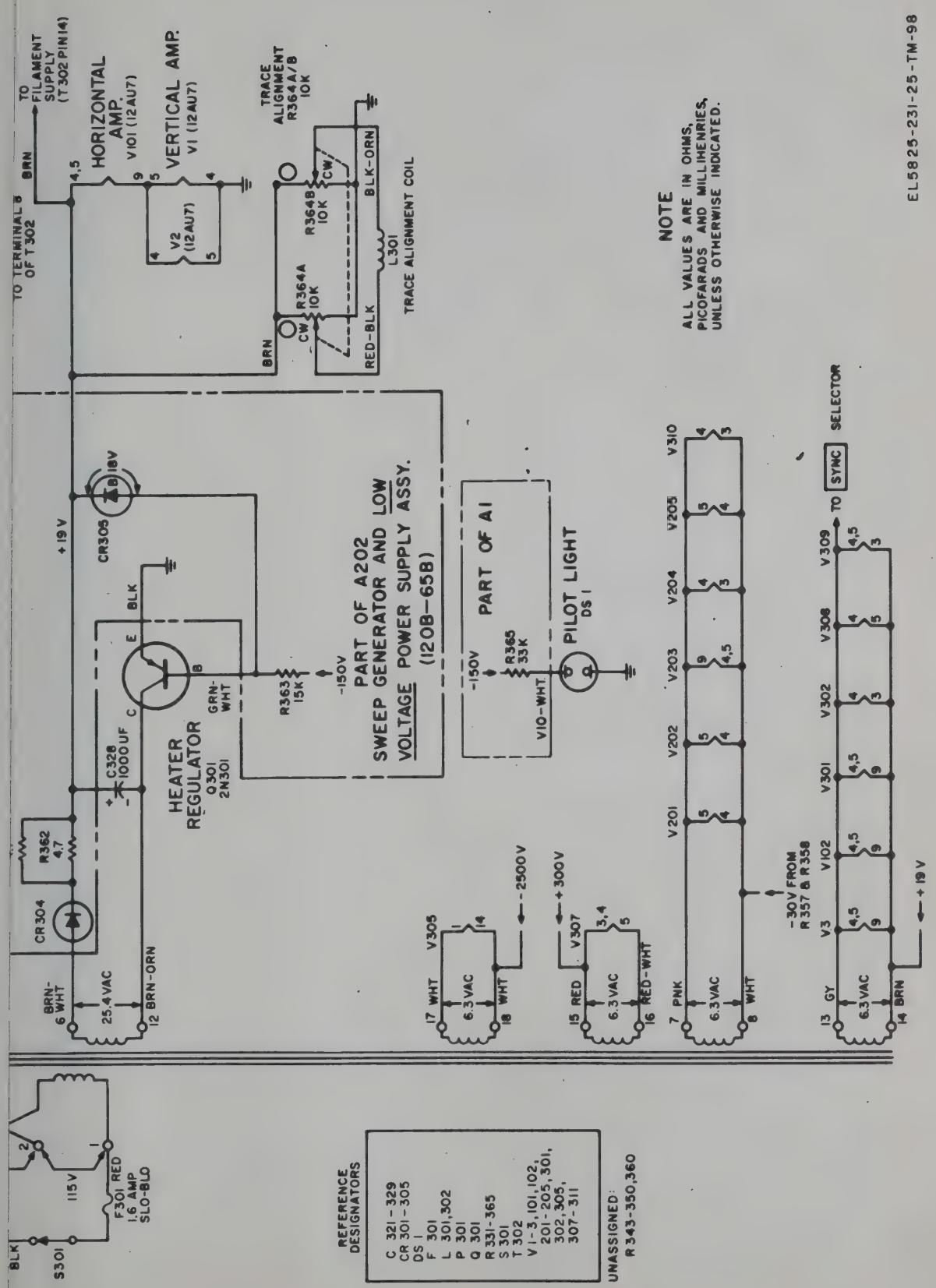
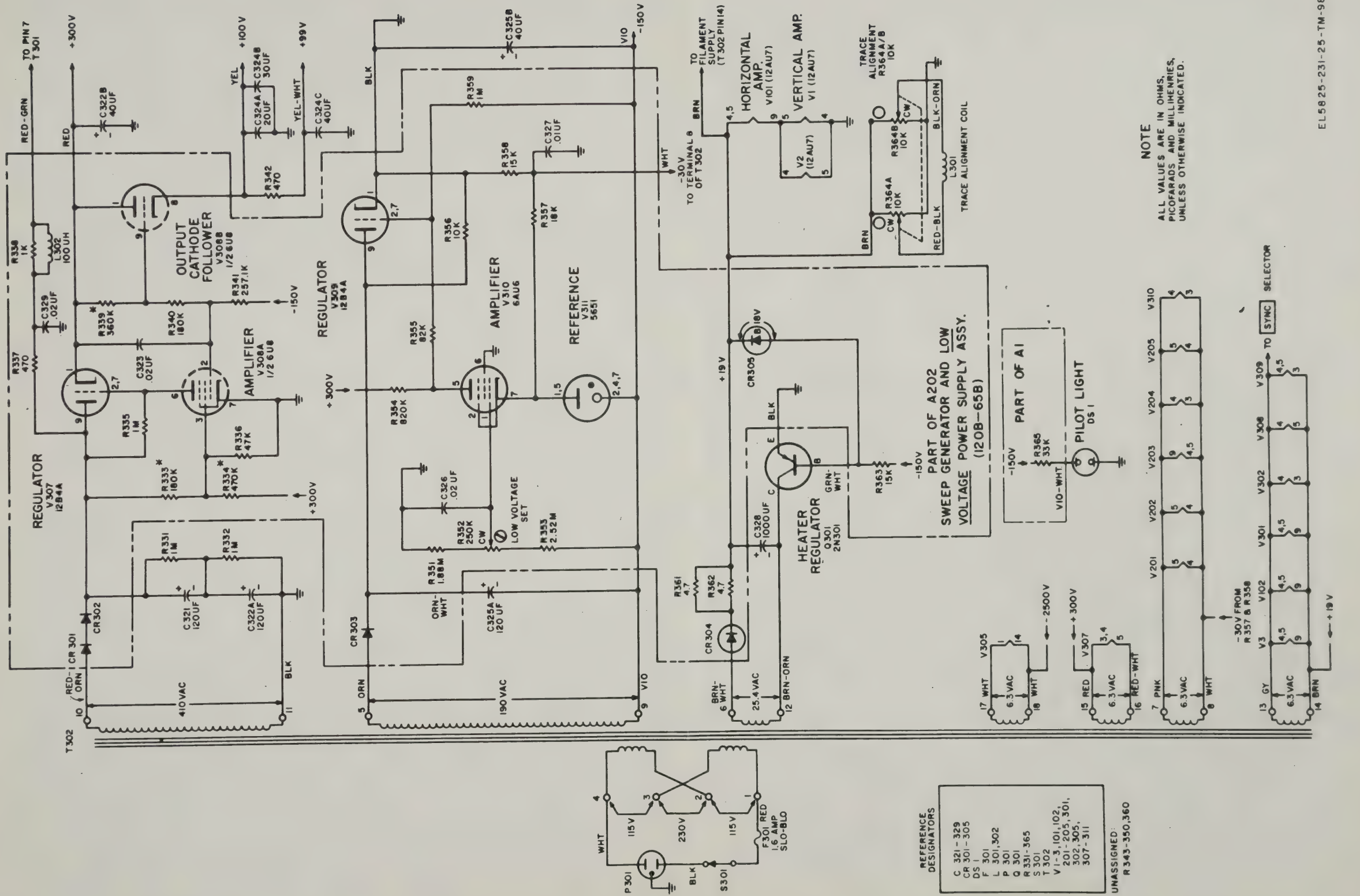
FO-12. Monitor oscilloscope, schematic diagram, vertical amplifier.



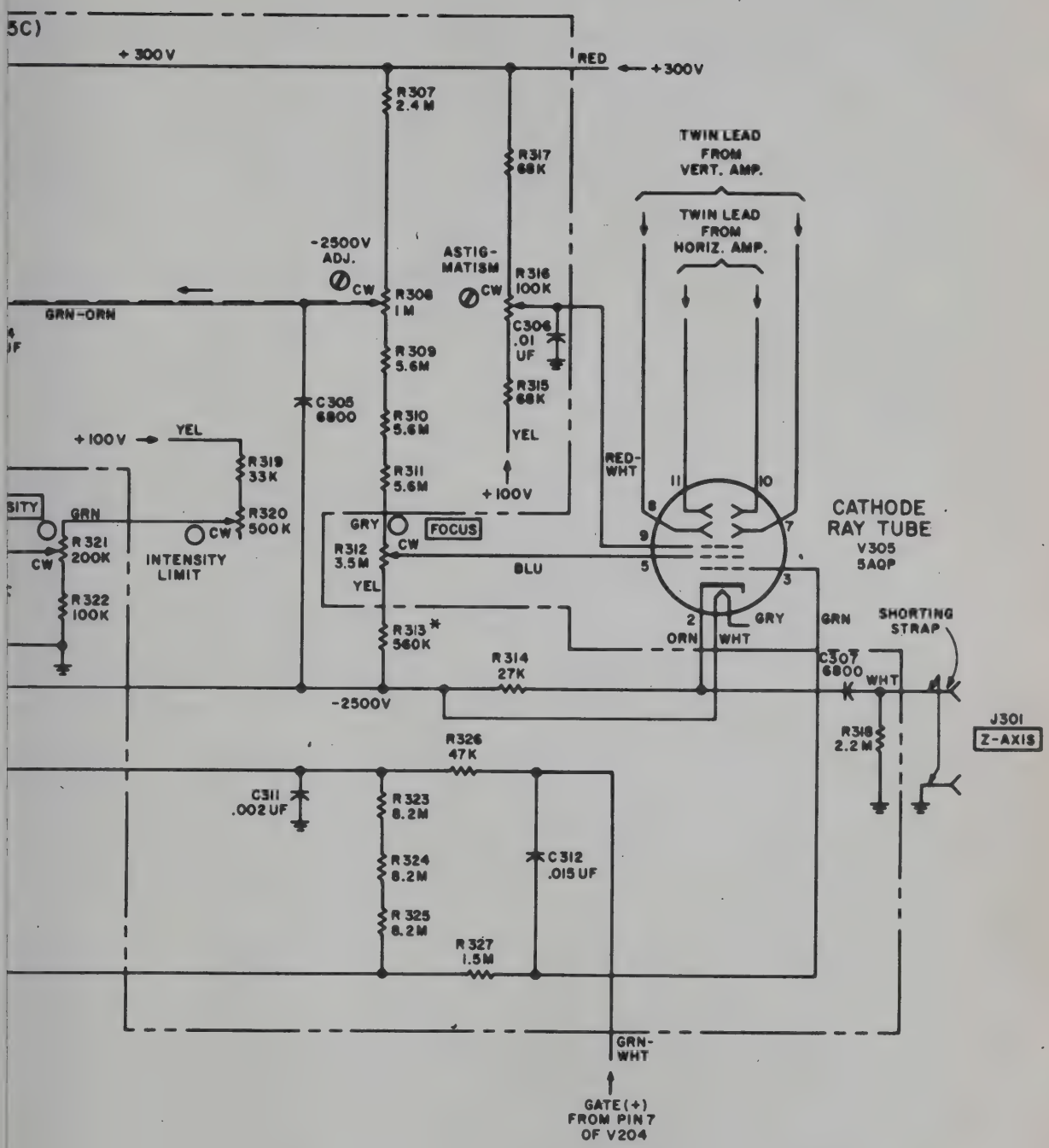
FO-12. Monitor oscilloscope, schematic diagram, vertical amplifier.



FO–13. Monitor oscilloscope 120B, schematic diagram, power supply.

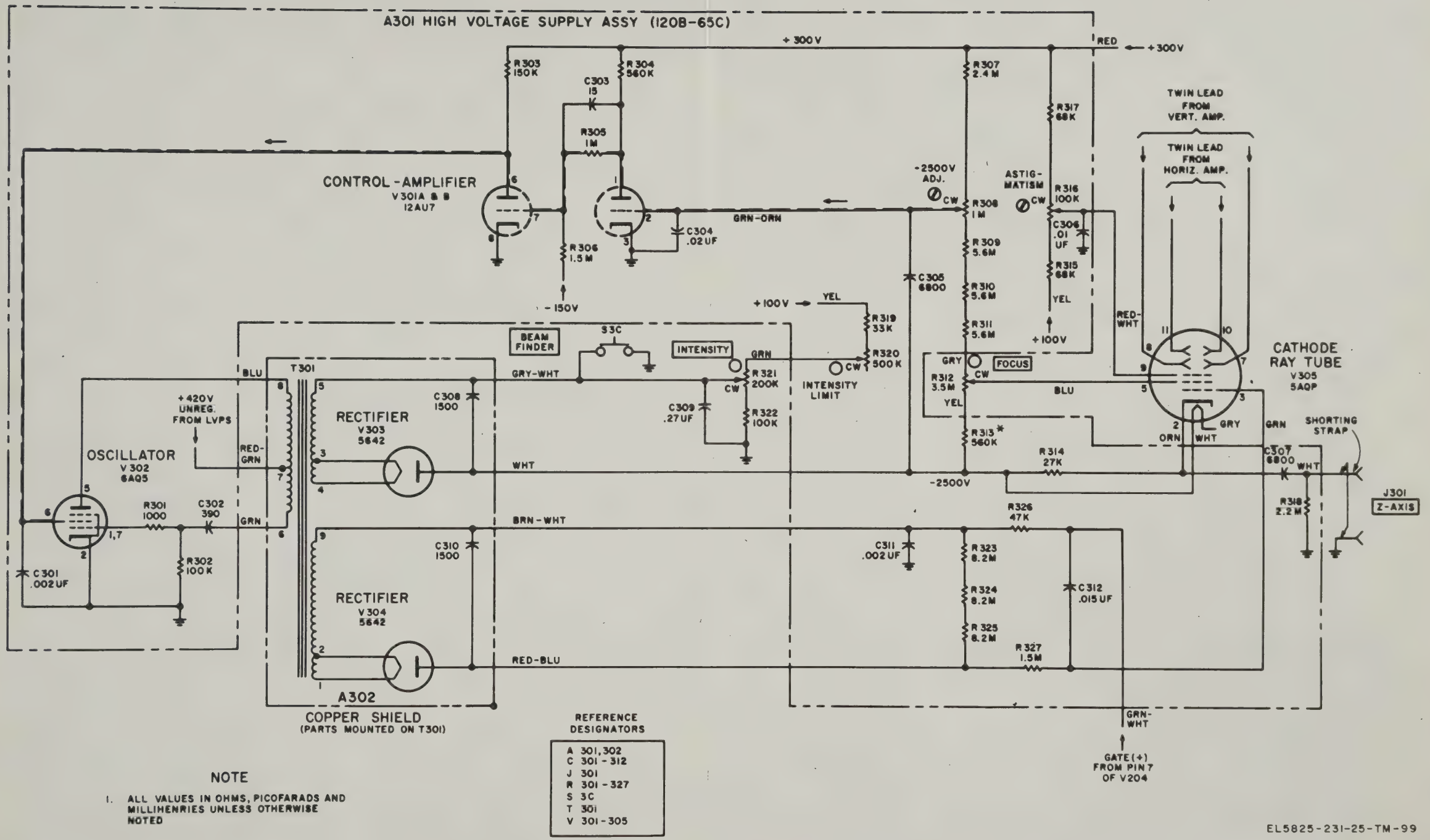


FO–13. Monitor oscilloscope 120B, schematic diagram, power supply.

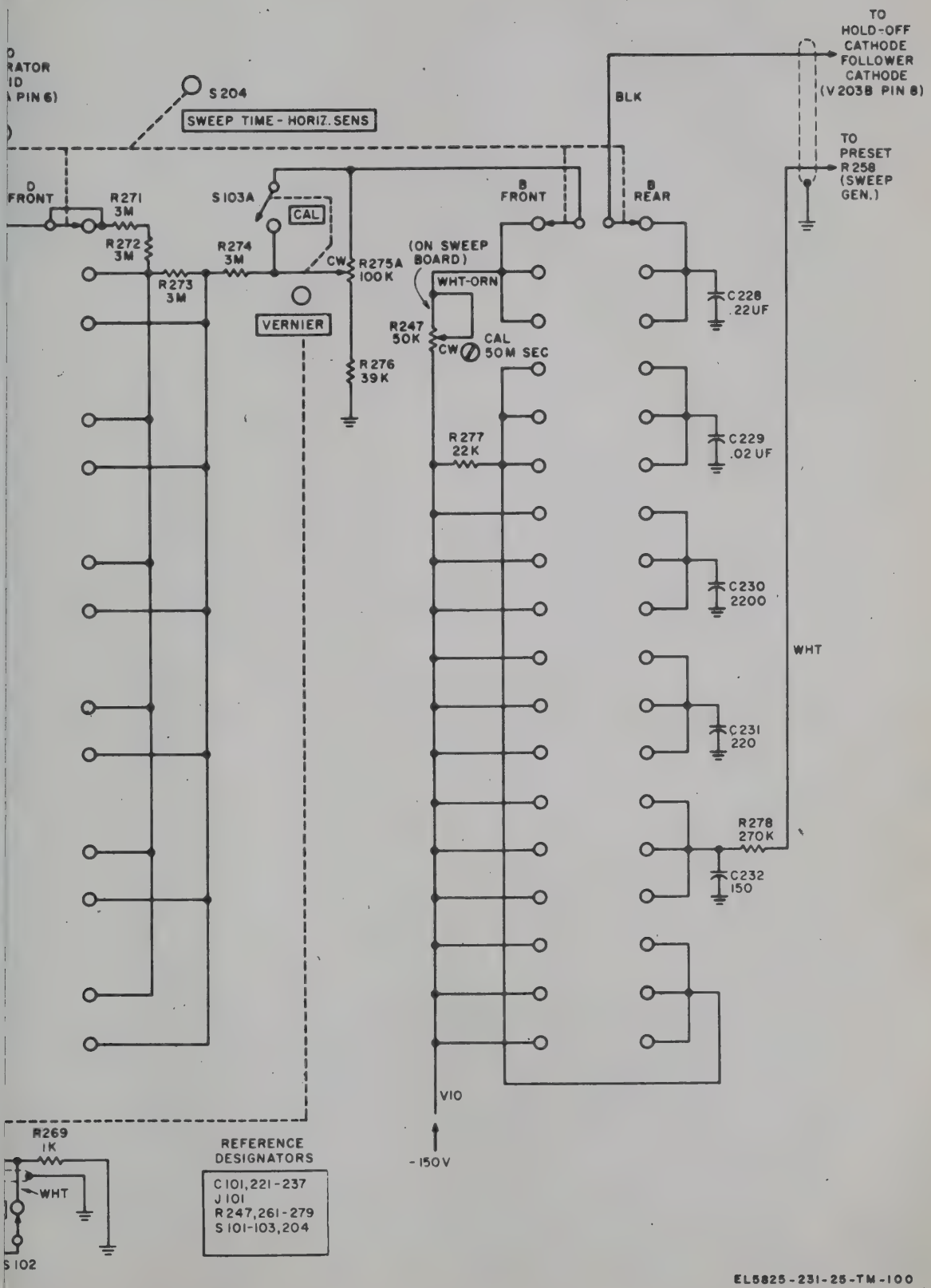


EL5825-231-25-TM-99

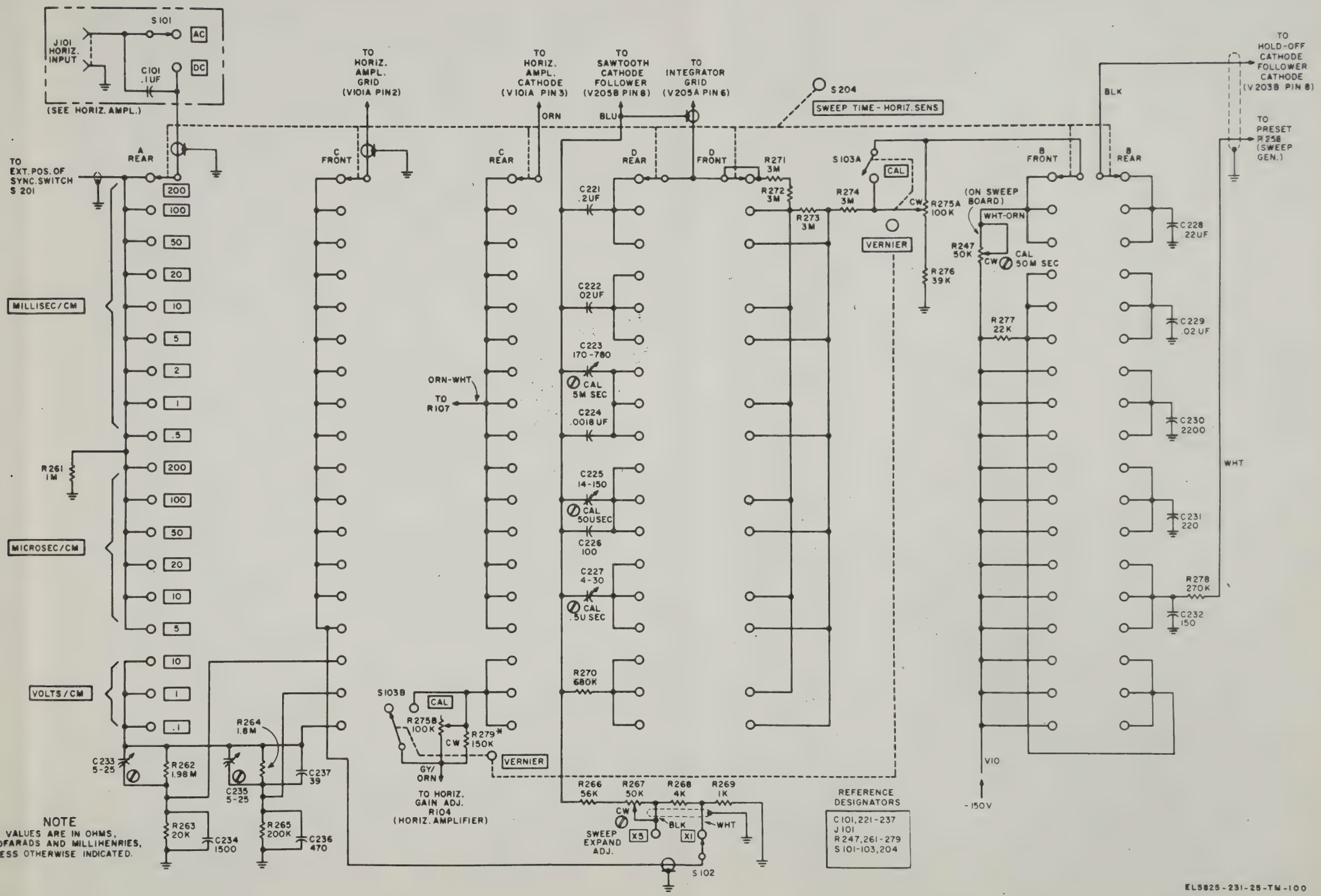
FO–14. Monitor oscilloscope 120B, schematic diagram, high-voltage power supply and indicator.



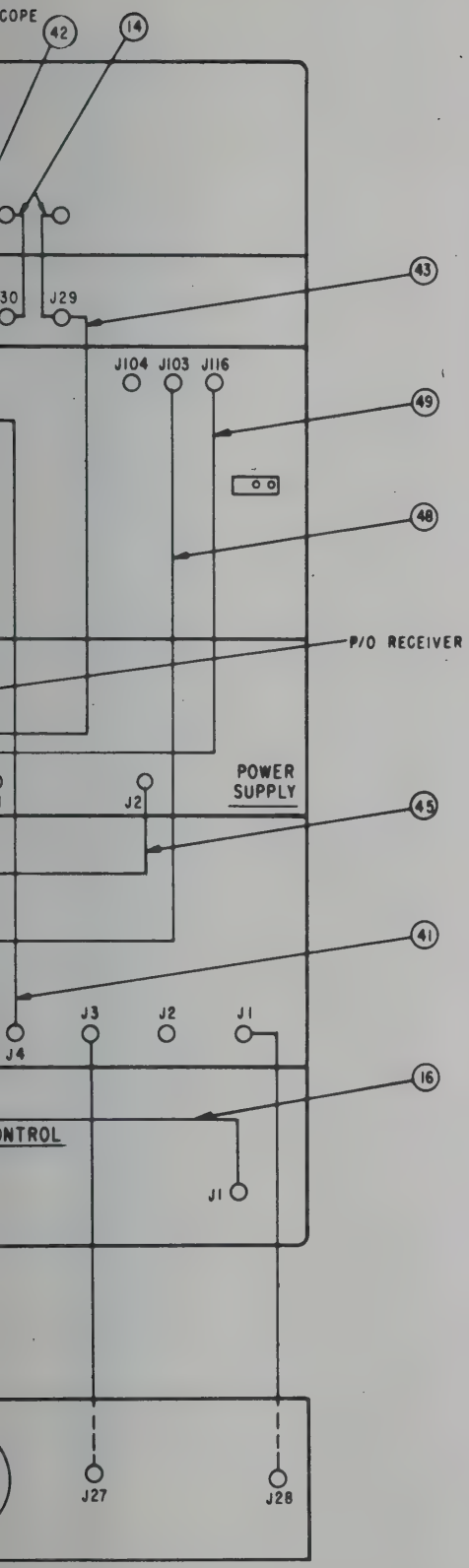
FO-14. Monitor oscilloscope 120B, schematic diagram, high-voltage power supply and indicator.

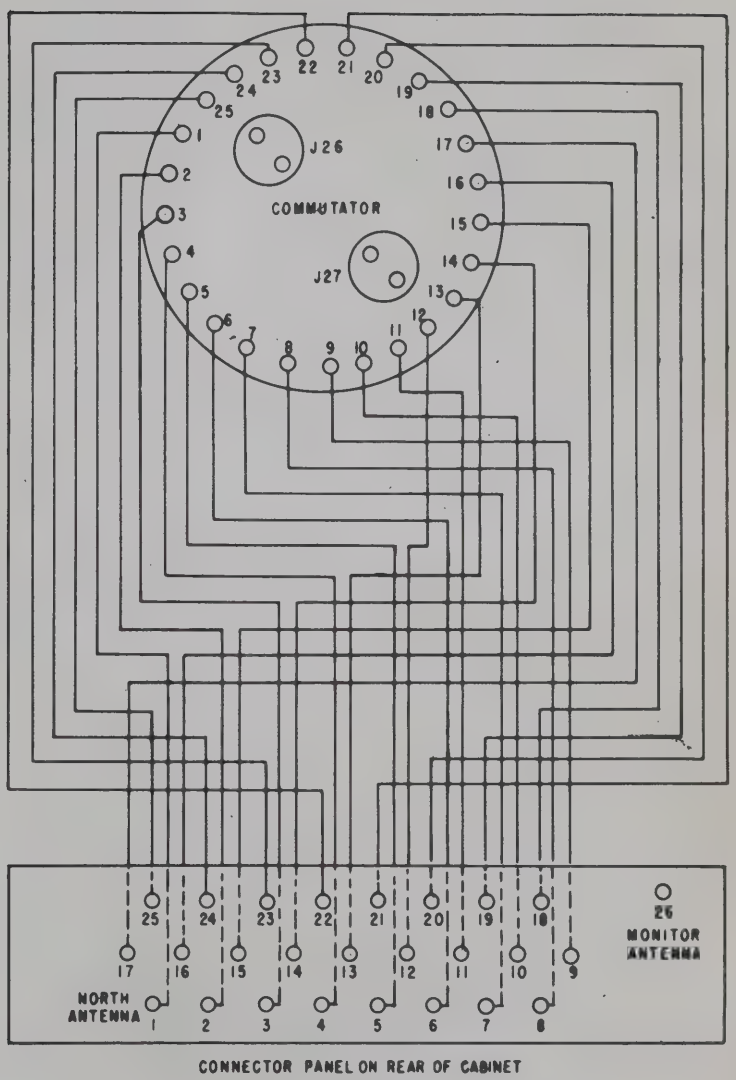


FO–15. Monitor oscilloscope 120B, schematic diagram, selector switch circuits.



FO–15. Monitor oscilloscope 120B, schematic diagram, selector switch circuits.





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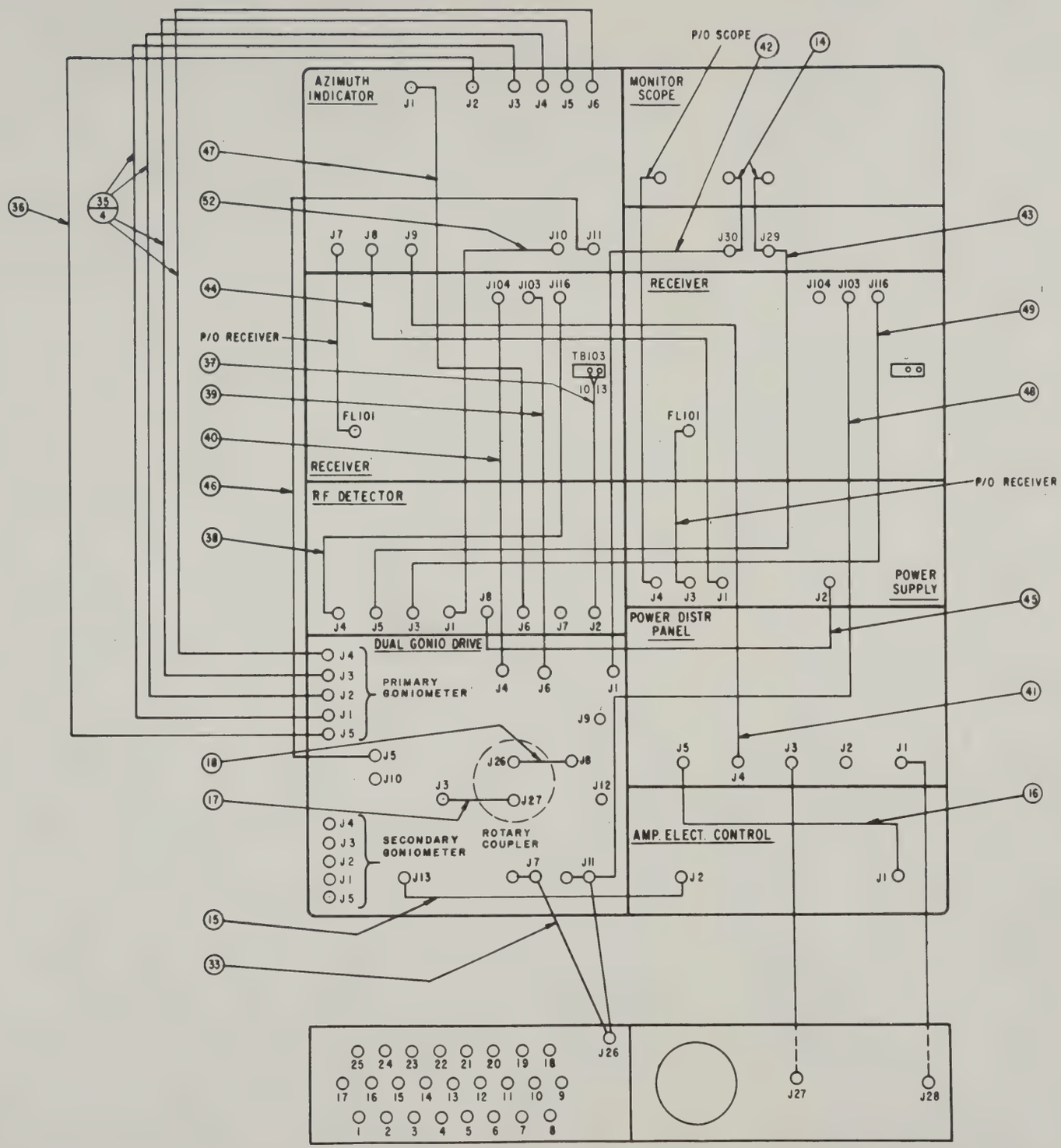
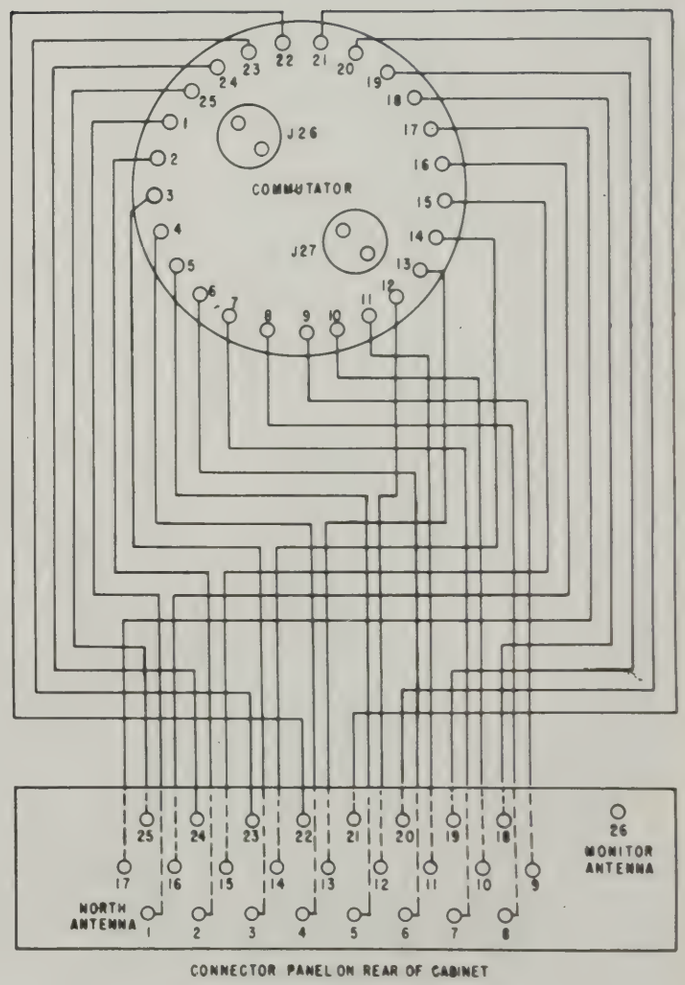
FO–16. AN/TRD–15(*), primary console, cabling diagram.

CABLE LIST

(14) CG-3211/U1FT
(15) CX-11222/U3FT6IN
(16) CX-11224/U2FT6IN
(17) CG-1079B/U2FT
(18) CG-1079B/U2FT6IN
(33) CG-3178/TRD
(35) CG-409G/U6FT
(36) CG-1079B/U6FT
(37) CX-11221/U3FT
(38) CG-409G/U3FT
(39) CG-833A/U4FT6IN
(40) CG-1079B/U5FT6IN
(41) CX-11180/U5FT6IN
(42) CG-409G/U5FT6IN
(43) CG-409G/U6FT6IN
(44) CX-11226/U6FT
(45) CX-11223/U3FT
(46) CX-11480/U5FT
(47) CG-409G/U4FT6IN
(48) CG-833A/U5FT
(49) CG-409G/U5FT
(52) CX-11228/U3FT4IN



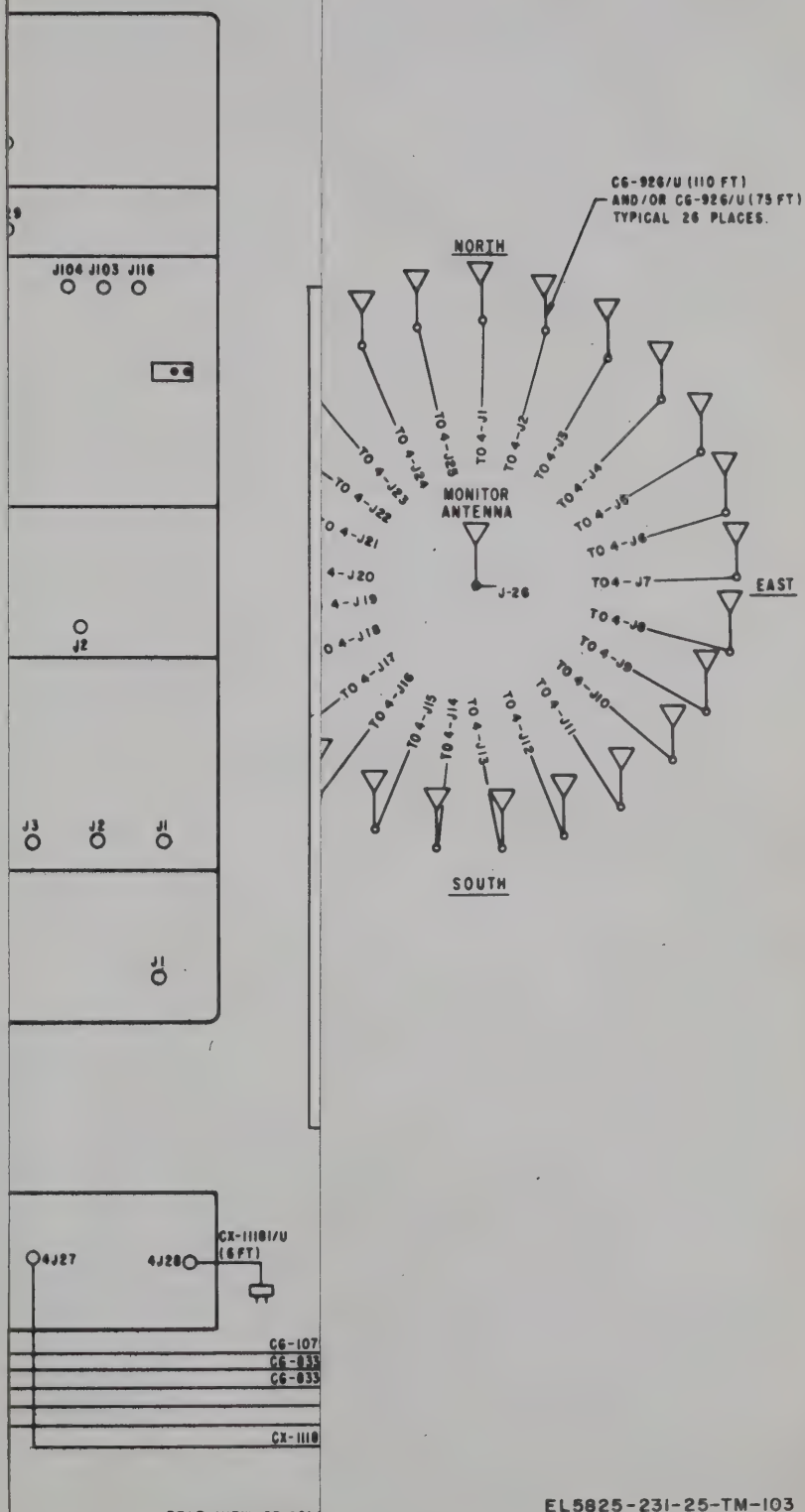
REAR PANELS



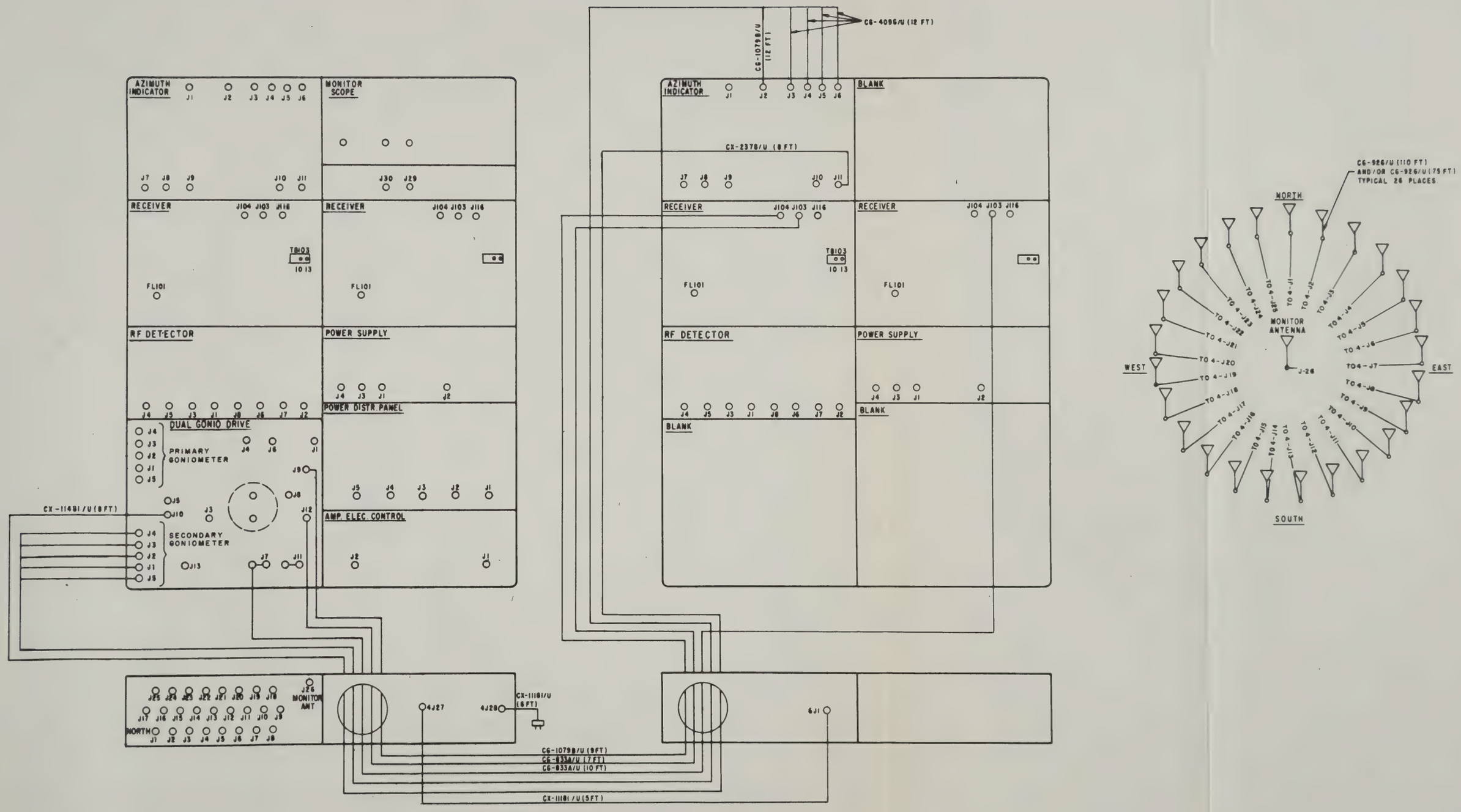
CONNECTOR PANEL ON REAR OF CABINET

EL5825-231-25-TM-102

FO-16. AN/TRD-15(*), primary console, cabling diagram.



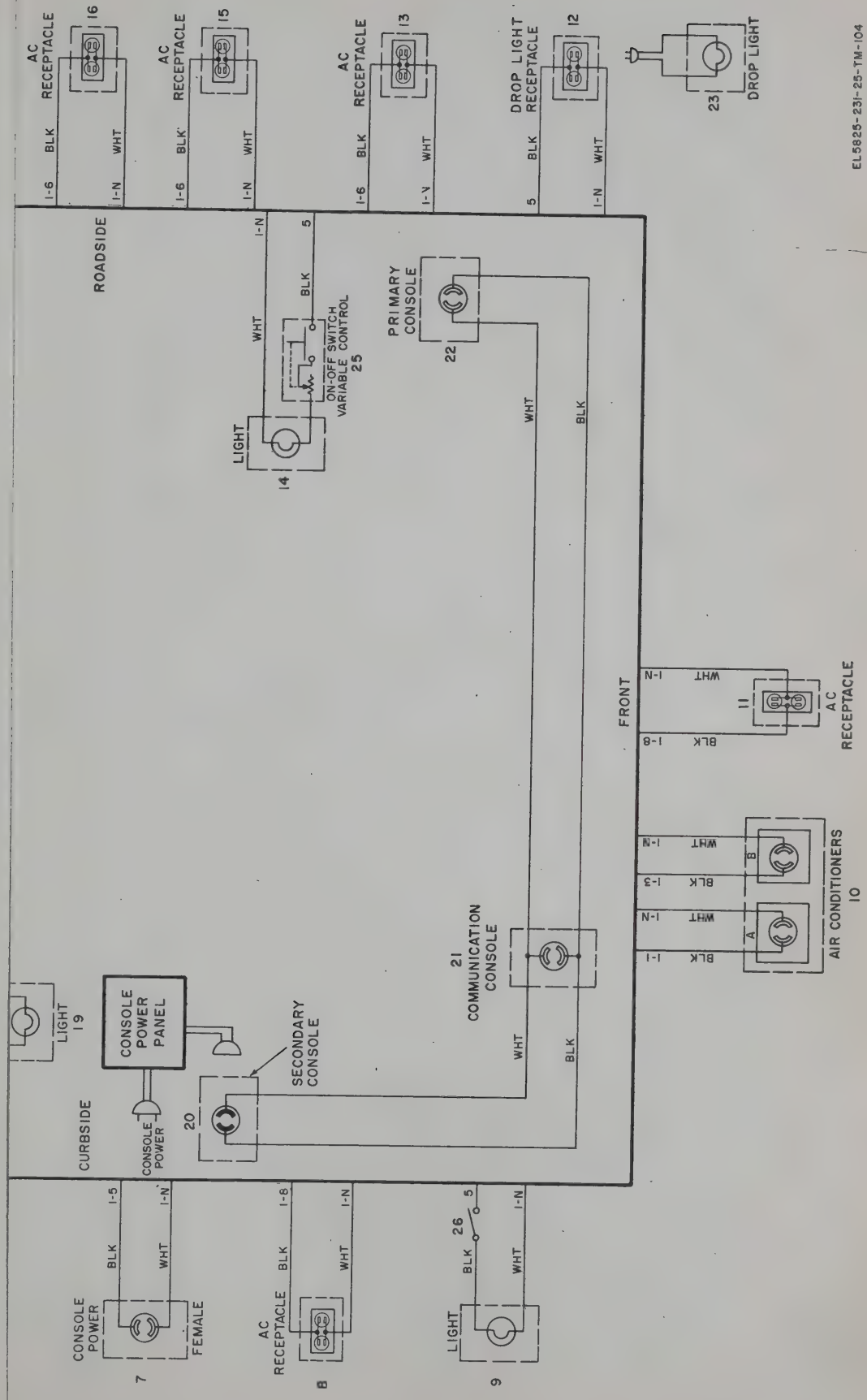
FO-17. AN/TRD-15(*), interunit cabling.



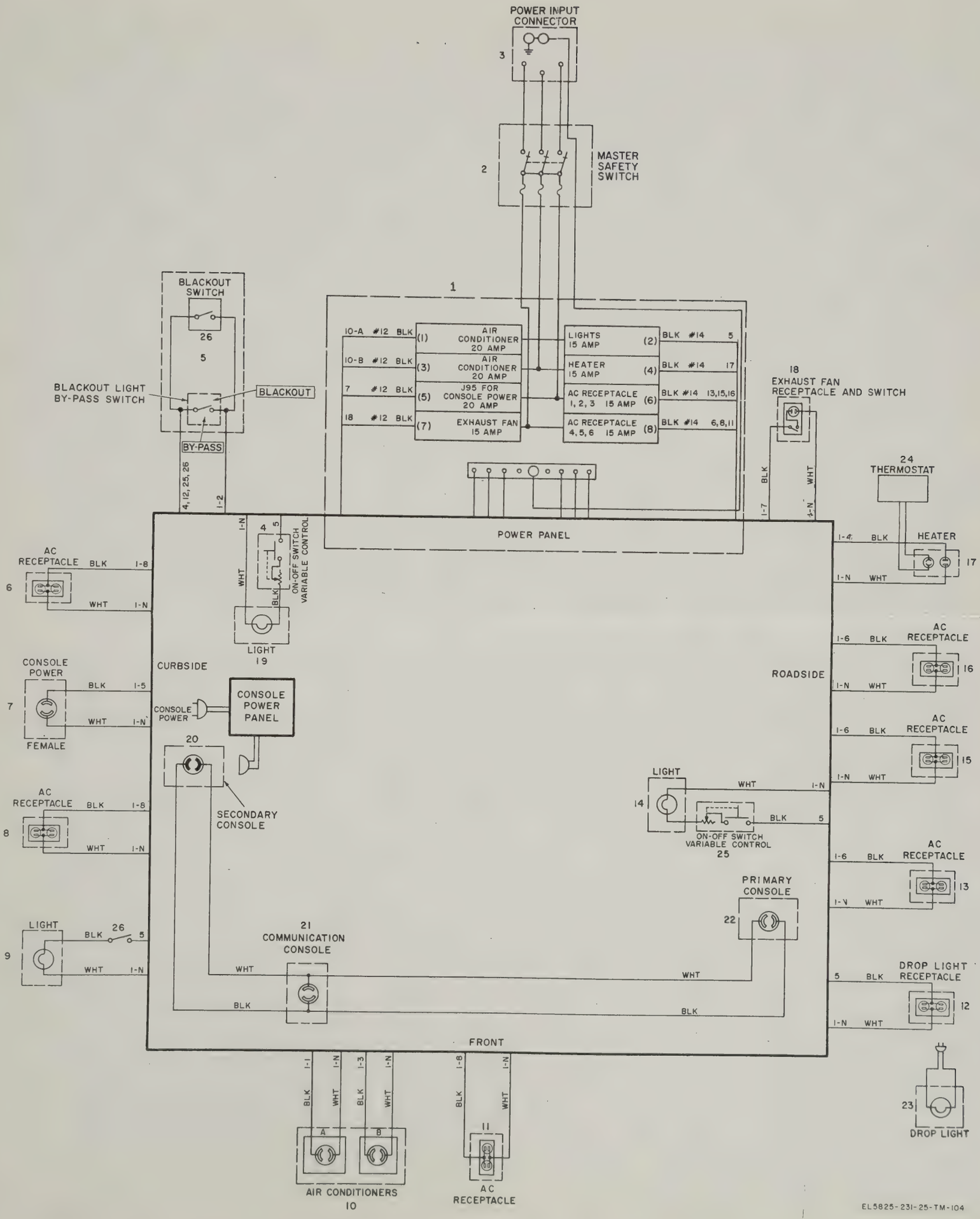
REAR VIEW OF CONSOLES

EL5825-231-25-TM-103

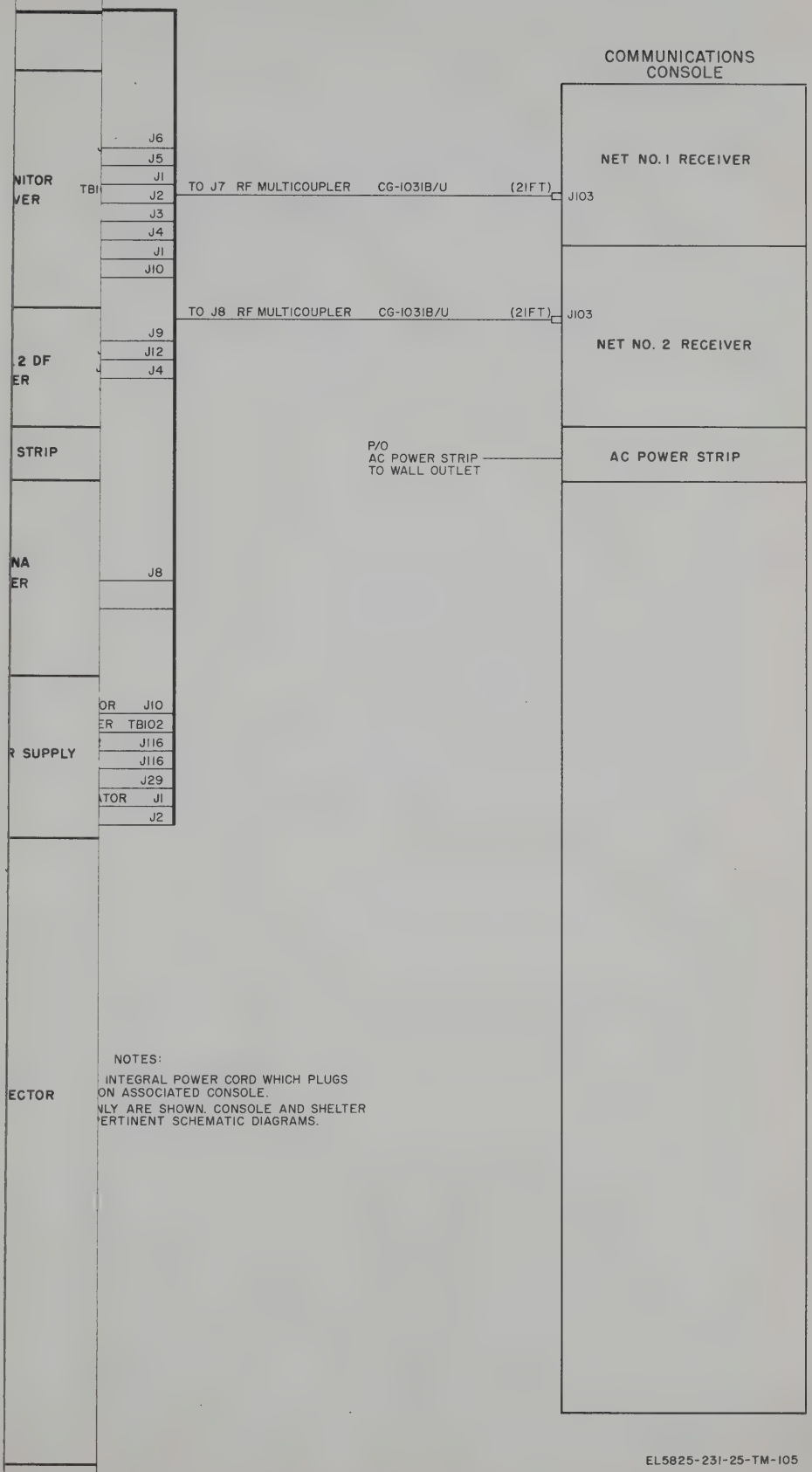
FO–17. AN/TRD–15(*), interunit cabling.



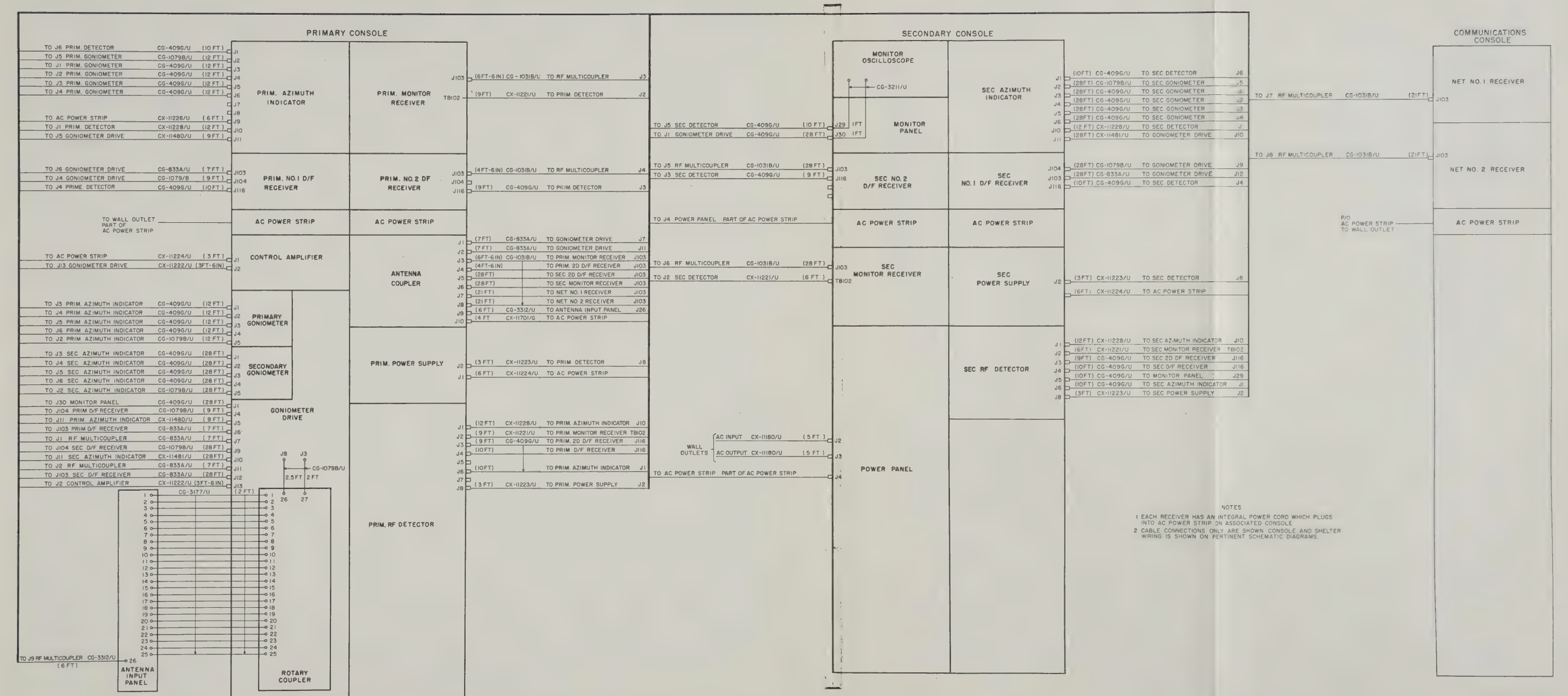
FO–18. AN/TRD–23(*), shelter power, schematic diagram.



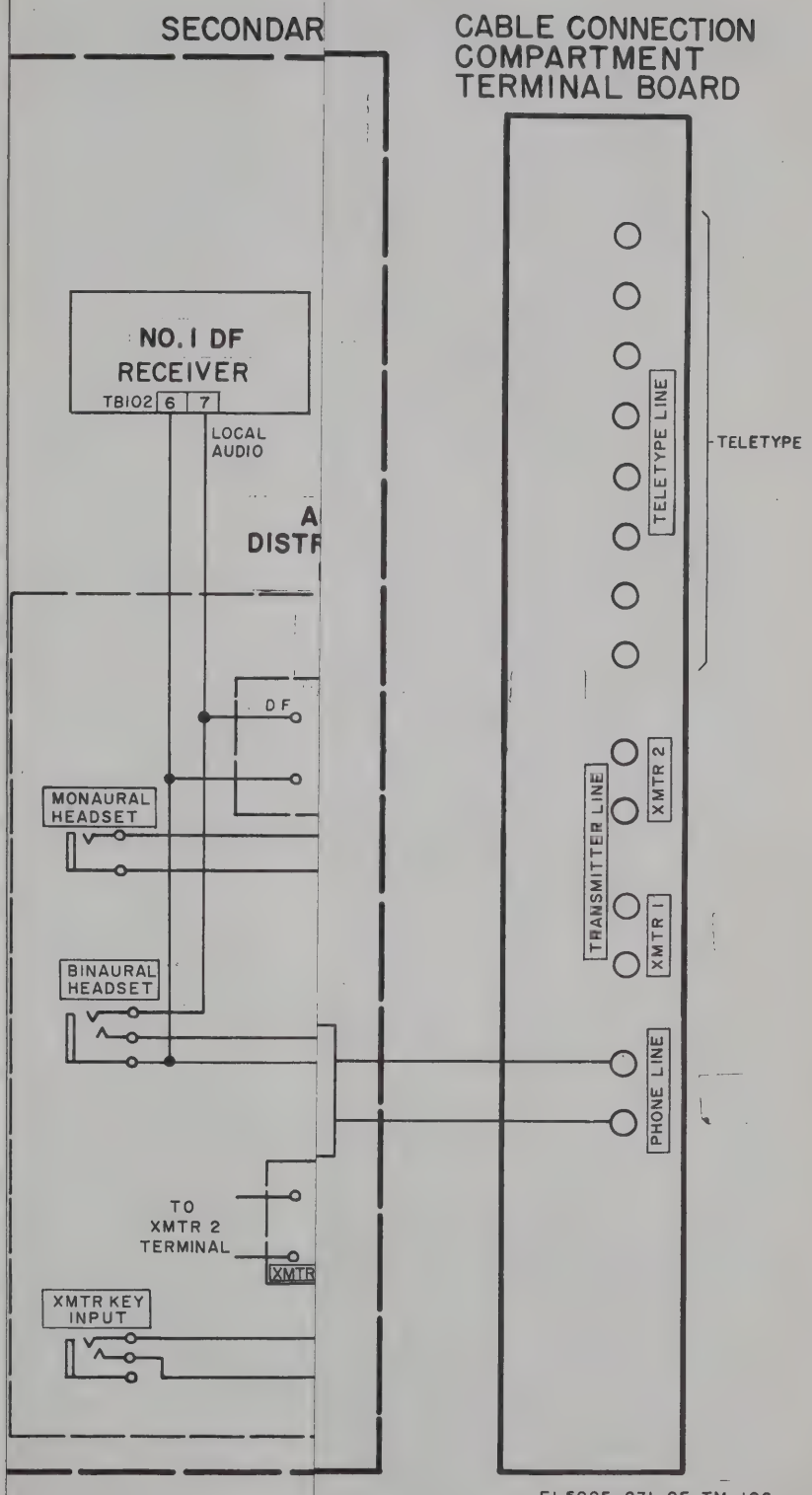
FO-18. AN/TRD-23(*), shelter power, schematic diagram.



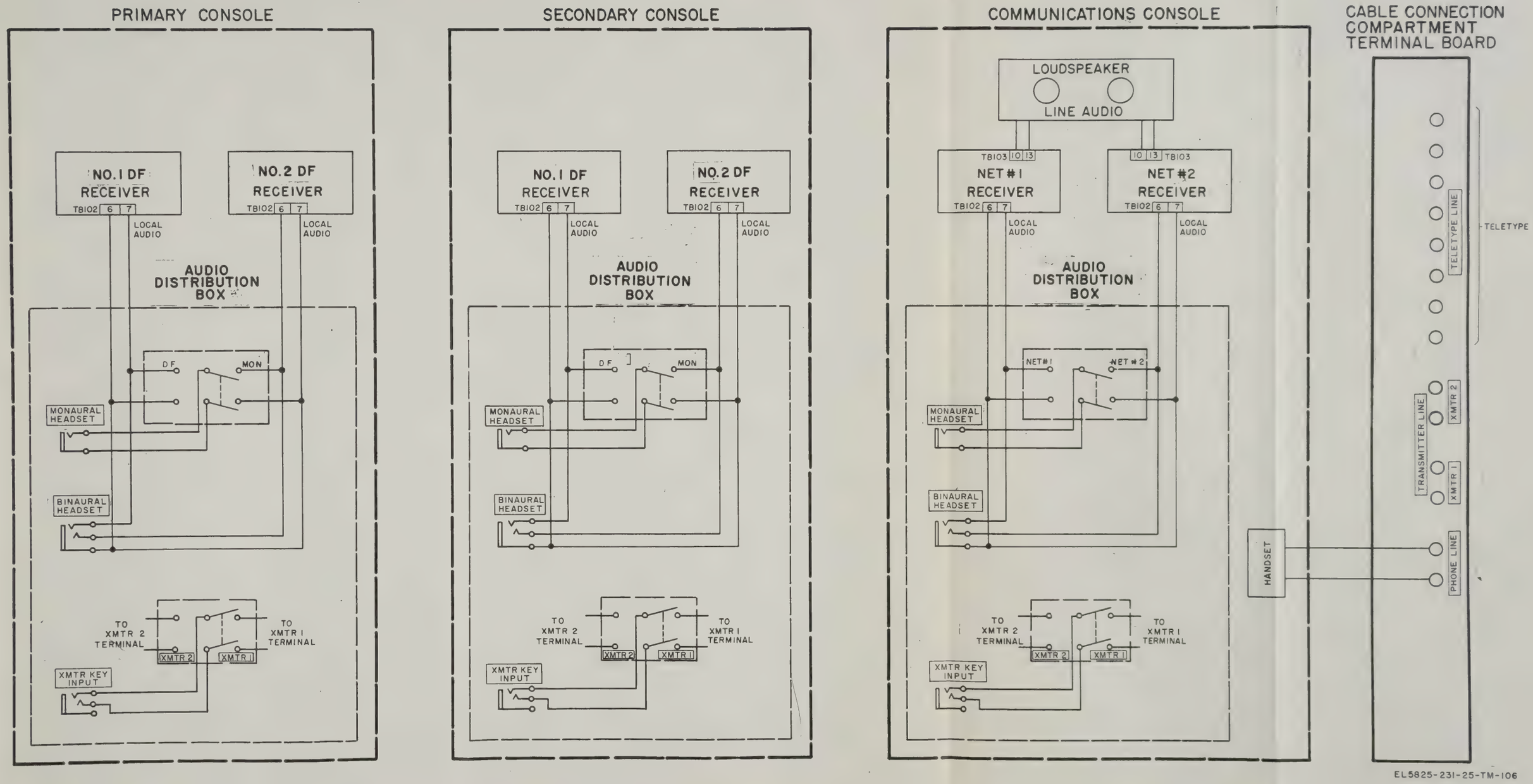
FO-19. AN-TRD-23(*), interunit cabling.


PRIMARY CONSOLE
TO J6 PRIM. DETECTOR CG-409G/U (10 FT)
TO J5 PRIM. GONIOMETER CG-1079B/U (12 FT)
TO J1 PRIM. GONIOMETER CG-409G/U (12 FT)
TO J2 PRIM. GONIOMETER CG-409G/U (12 FT)
TO J3 PRIM. GONIOMETER CG-409G/U (12 FT)
TO J4 PRIM. GONIOMETER CG-409G/U (12 FT)
PRIM. AZIMUTH INDICATOR
TO AC POWER STRIP CX-11226/U (6 FT)
TO J1 PRIM. DETECTOR CX-11228/U (12 FT)
TO J5 GONIOMETER DRIVE CX-11480/U (9 FT)
PRIM. MONITOR RECEIVER
J103 (6FT-6IN) CG-1031B/U TO RF MULTICOUPLER J3
TB102 (9FT) CX-11221/U TO PRIM DETECTOR J2
TO J6 GONIOMETER DRIVE CG-833A/U (7 FT)
TO J4 GONIOMETER DRIVE CG-1079/B (9 FT)
TO J4 PRIME. DETECTOR CG-409G/U (10 FT)
PRIM. NO.1 D/F RECEIVER
PRIM. NO.2 DF RECEIVER
J103 (4FT-6IN) CG-1031B/U TO RF MULTICOUPLER J4
J104
J116 (9FT) CG-409G/U TO PRIM DETECTOR J3
TO WALL OUTLET PART OF AC POWER STRIP
AC POWER STRIP
AC POWER STRIP
TO AC POWER STRIP CX-11224/U (3 FT)
TO J13 GONIOMETER DRIVE CX-11222/U (3FT-6IN)
CONTROL AMPLIFIER
ANTENNA COUPLER
J1 (7FT) CG-833A/U TO GONIOMETER DRIVE J7
J2 (7FT) CG-833A/U TO GONIOMETER DRIVE J11
J3 (6FT-6IN) CG-1031B/U TO PRIM. MONITOR RECEIVER J103
J4 (4FT-6IN) TO PRIM. 2D D/F RECEIVER J103
J5 (28FT) TO SEC 2D D/F RECEIVER J103
J6 (28FT) TO SEC MONITOR RECEIVER J103
J7 (21FT) TO NET NO. 1 RECEIVER J103
J8 (21FT) TO NET NO 2 RECEIVER J103
J9 (6 FT) CG-3312/U TO ANTENNA INPUT PANEL J26
J10 (4 FT CX-11701/G TO AC POWER STRIP
TO J3 PRIM. AZIMUTH INDICATOR CG-409G/U (12 FT)
TO J4 PRIM. AZIMUTH INDICATOR CG-409G/U (12 FT)
TO J5 PRIM. AZIMUTH INDICATOR CG-409G/U (12 FT)
TO J6 PRIM. AZIMUTH INDICATOR CG-409G/U (12 FT)
TO J2 PRIM. AZIMUTH INDICATOR CG-1079B/U (12 FT)
PRIMARY GONIOMETER
TO J3 SEC. AZIMUTH INDICATOR CG-409G/U (28 FT)
TO J4 SEC. AZIMUTH INDICATOR CG-409G/U (28 FT)
TO J5 SEC. AZIMUTH INDICATOR CG-409G/U (28 FT)
TO J6 SEC. AZIMUTH INDICATOR CG-409G/U (28 FT)
TO J2 SEC. AZIMUTH INDICATOR CG-1079B/U (28 FT)
SECONDARY GONIOMETER
PRIM. POWER SUPPLY
J2 (3 FT) CX-11223/U TO PRIM DETECTOR J8
J1 (6 FT) CX-11224/U TO AC POWER STRIP
TO J30 MONITOR PANEL CG-409G/U (28 FT)
TO J104 PRIM D/F RECEIVER CG-1079B/U (9 FT)
TO J11 PRIM. AZIMUTH INDICATOR CX-11480/U (9 FT)
TO J103 PRIM D/F RECEIVER CG-833A/U (7 FT)
TO J1 RF MULTICOUPLER CG-833A/U (7 FT)
TO J104 SEC D/F RECEIVER CG-1079B/U (28 FT)
TO J11 SEC AZIMUTH INDICATOR CX-11481/U (28 FT)
TO J2 RF MULTICOUPLER CG-833A/U (7 FT)
TO J103 SEC D/F RECEIVER CG-833A/U (28 FT)
TO J2 CONTROL AMPLIFIER CX-11222/U (3FT-6IN)
GONIOMETER DRIVE
J8
J3
CG-1079B/U
2.5FT 2FT
CG-3177/U (2 FT)
26
27
PRIM. RF DETECTOR
J1 (12FT) CX-11228/U TO PRIM. AZIMUTH INDICATOR J10
J2 (9 FT) CX-11221/U TO PRIM. MONITOR RECEIVER TB102
J3 (9 FT) CG-409G/U TO PRIM. 2D D/F RECEIVER J116
J4 (10FT) TO PRIM D/F RECEIVER J116
J5
J6 (10FT) TO PRIM. AZIMUTH INDICATOR J1
J7
J8 (3 FT) CX-11223/U TO PRIM. POWER SUPPLY J2
TO J9 RF MULTICOUPLER CG-3312/U (6 FT)
26
ANTENNA INPUT PANEL
ROTARY COUPLER
SECONDARY CONSOLE
MONITOR OSCILLOSCOPE
CG-3211/U
MONITOR PANEL
TO J5 SEC DETECTOR CG-409G/U (10 FT) J29 1FT
TO J1 GONIOMETER DRIVE CG-409G/U (28 FT) J30 1FT
SEC AZIMUTH INDICATOR
J1 (10FT) CG-409G/U TO SEC DETECTOR J6
J2 (28FT) CG-1079B/U TO SEC GONIOMETER J5
J3 (28FT) CG-409G/U TO SEC GONIOMETER J
J4 (28FT) CG-409G/U TO SEC GONIOMETER J2
J5 (28FT) CG-409G/U TO SEC GONIOMETER J3
J6 (28FT) CG-409G/U TO SEC GONIOMETER J4
J10 (12 FT) CX-11228/U TO SEC DETECTOR J
J11 (28FT) CX-11481/U TO GONIOMETER DRIVE J10
TO J5 RF MULTICOUPLER CG-1031B/U (28 FT)
TO J3 SEC DETECTOR CG-409G/U (9 FT)
J103
J116
SEC NO. 2 D/F RECEIVER
SEC NO.1 D/F RECEIVER
J104 (28FT) CG-1079B/U TO GONIOMETER DRIVE J9
J103 (28FT) CG-833A/U TO GONIOMETER DRIVE J12
J116 (10FT) CG-409G/U TO SEC DETECTOR J4
TO J4 POWER PANEL PART OF AC POWER STRIP
AC POWER STRIP
AC POWER STRIP
TO J6 RF MULTICOUPLER CG-1031B/U (28 FT)
TO J2 SEC DETECTOR CX-11221/U (6 FT)
J103
TB102
SEC MONITOR RECEIVER
SEC POWER SUPPLY
J2 (3FT) CX-11223/U TO SEC DETECTOR J8
(6FT) CX-11224/U TO AC POWER STRIP
WALL OUTLETS
AC INPUT CX-11180/U (5 FT) J2
AC OUTPUT CX-11180/U (5 FT) J3
TO AC POWER STRIP PART OF AC POWER STRIP J4
POWER PANEL
SEC RF DETECTOR
J1 (12FT) CX-11228/U TO SEC AZIMUTH INDICATOR J10
J2 (6FT) CX-11221/U TO SEC MONITOR RECEIVER TB102
J3 (9FT) CG-409G/U TO SEC 2D DF RECEIVER J116
J4 (10FT) CG-409G/U TO SEC D/F RECEIVER J116
J5 (10FT) CG-409G/U TO MONITOR PANEL J29
J6 (10FT) CG-409G/U TO SEC AZIMUTH INDICATOR J1
J8 (3FT) CX-11223/U TO SEC POWER SUPPLY J2
COMMUNICATIONS CONSOLE
TO J7 RF MULTICOUPLER CG-1031B/U (21FT) J103
NET NO. 1 RECEIVER
TO J8 RF MULTICOUPLER CG-1031B/U (21FT) J103
NET NO. 2 RECEIVER
P/O AC POWER STRIP TO WALL OUTLET
AC POWER STRIP
NOTES
1 EACH RECEIVER HAS AN INTEGRAL POWER CORD WHICH PLUGS INTO AC POWER STRIP ON ASSOCIATED CONSOLE
2 CABLE CONNECTIONS ONLY ARE SHOWN. CONSOLE AND SHELTER WIRING IS SHOWN ON PERTINENT SCHEMATIC DIAGRAMS.
EL5825-231-25-TM-105

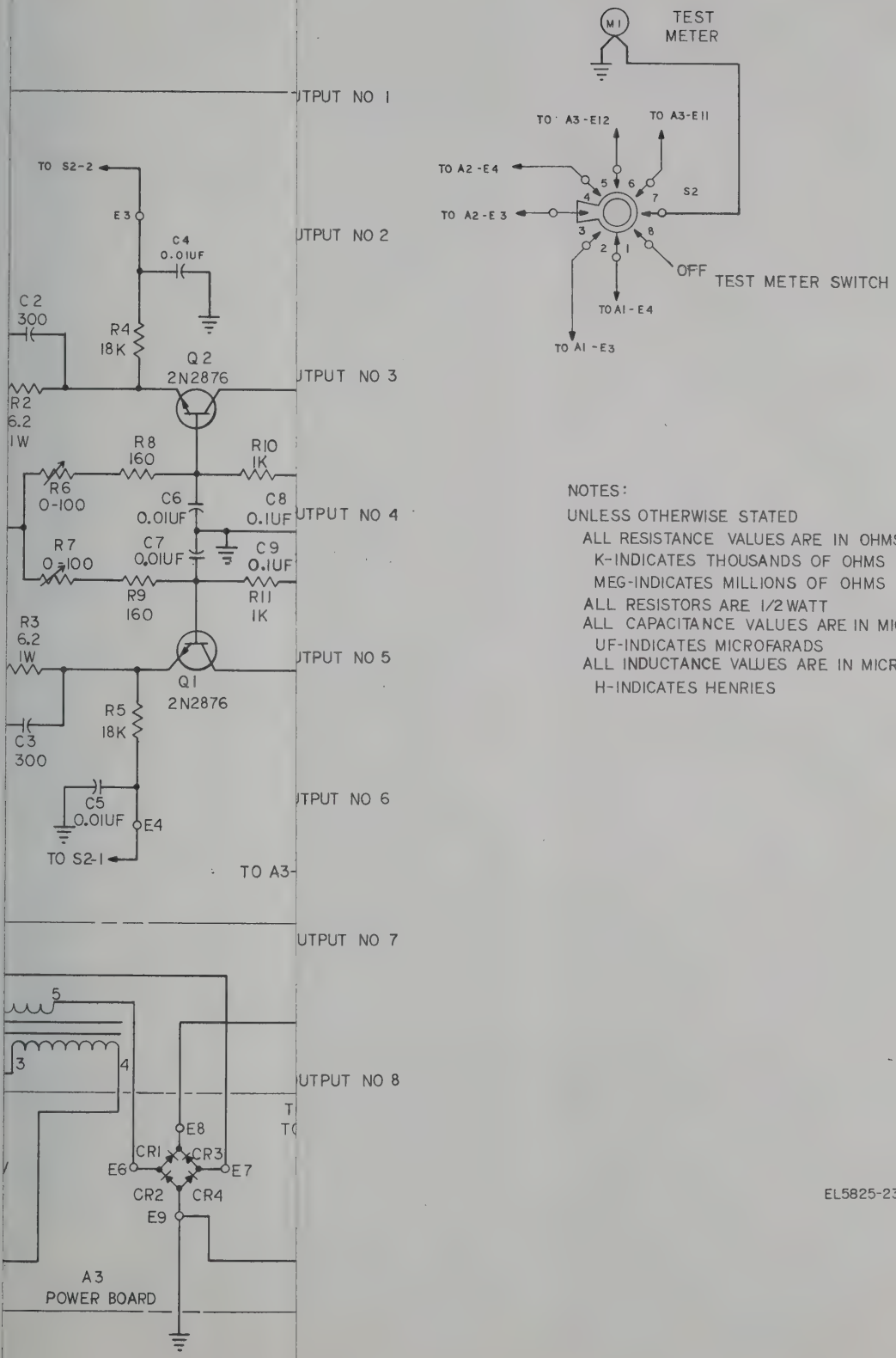
FO-19. AN-TRD-23(*), interunit cabling.



rol and audio switching, schematic diagram.



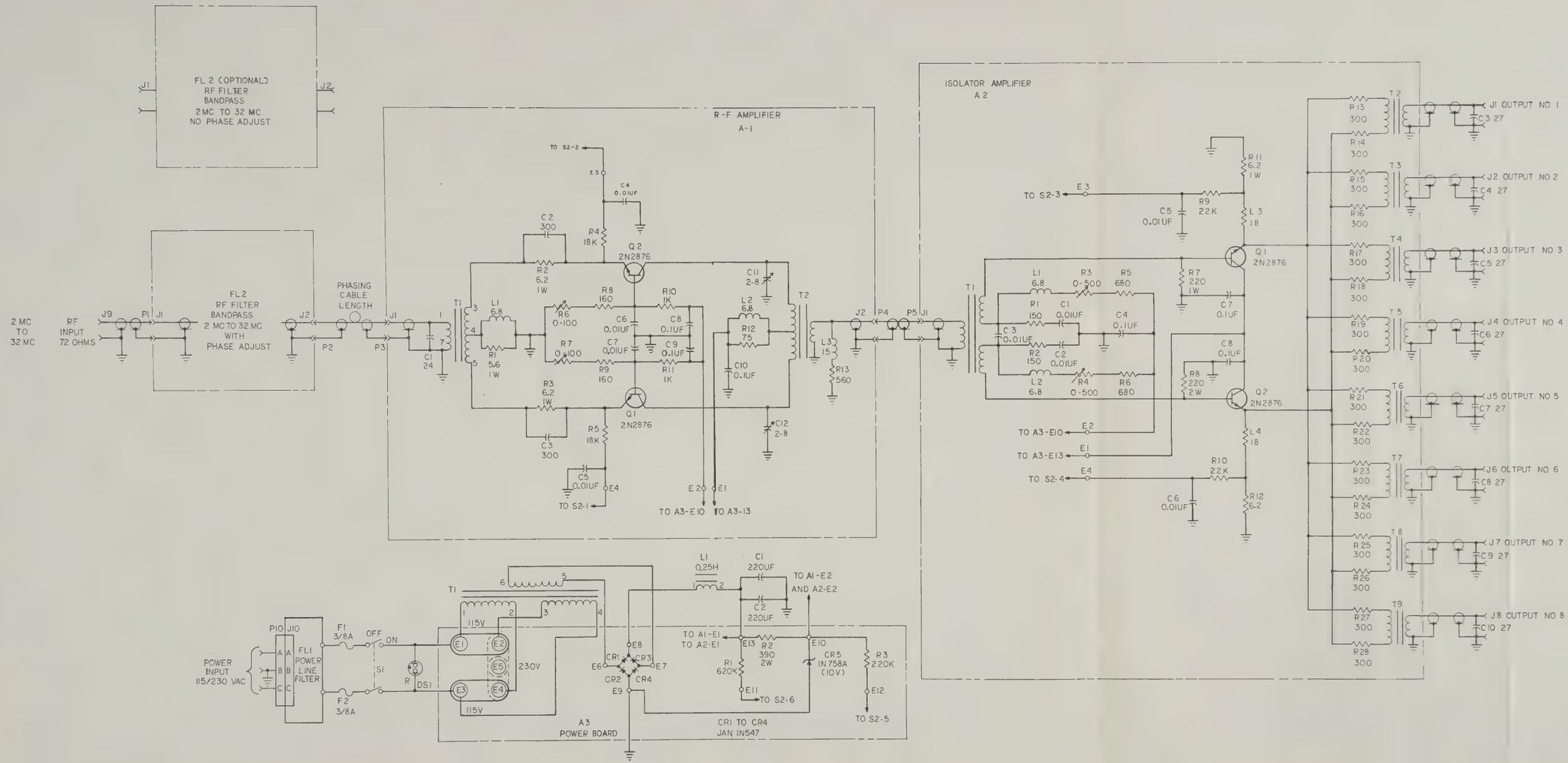
FO-20. AN/TRD-23(*), transmitter control and audio switching, schematic diagram.



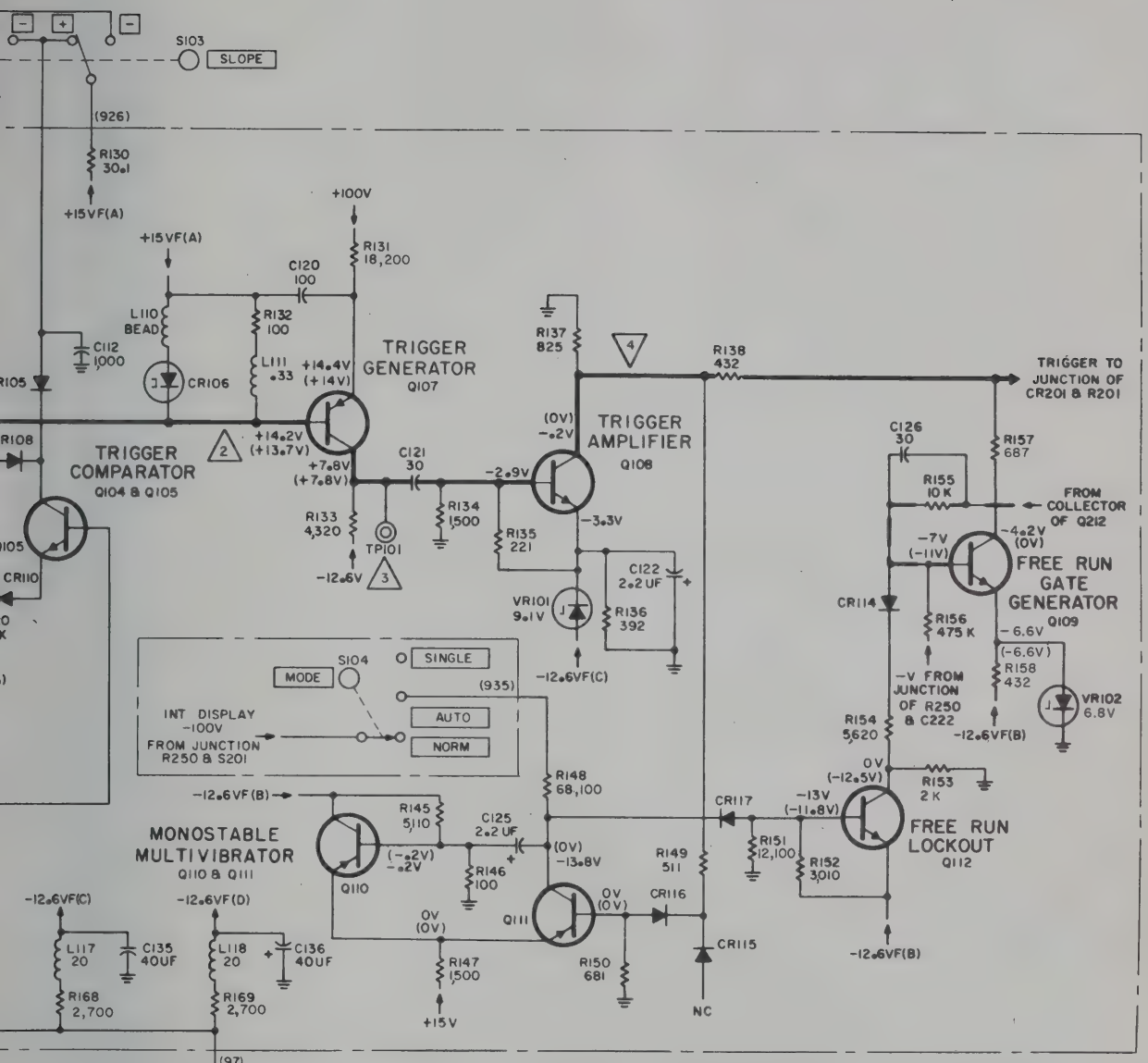
NOTES:
UNLESS OTHERWISE STATED
ALL RESISTANCE VALUES ARE IN OHMS
K-INDICATES THOUSANDS OF OHMS
MEG-INDICATES MILLIONS OF OHMS
ALL RESISTORS ARE 1/2 WATT
ALL CAPACITANCE VALUES ARE IN MICROFARADS
UF-INDICATES MICROFARADS
ALL INDUCTANCE VALUES ARE IN MICROHENRIES
H-INDICATES HENRIES

EL5825-231-25-TM-107

FO-21. Antenna coupler, schematic diagram.



FO-21. Antenna coupler, schematic diagram.

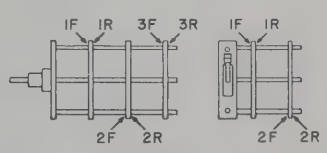


NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTANCES ARE IN OHMS.
   CAPACITANCES ARE IN PICOFARADS.
   INDUCTANCES ARE IN MICROHENRIES.
2. WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESES USING THE RESISTOR COLOR CODE (925 IS WHT-RED-GRN).

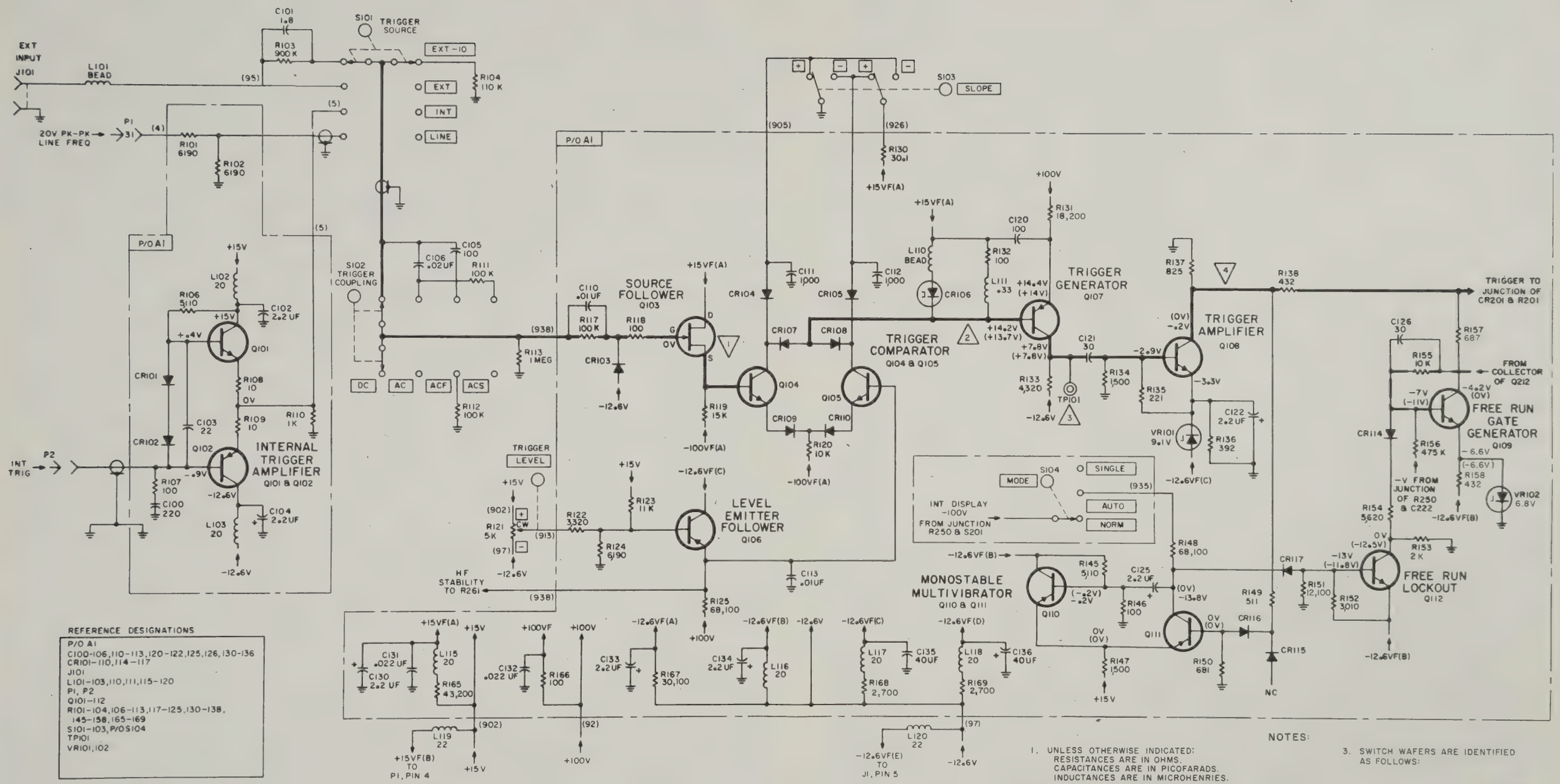
0 - BLACK	5 - GREEN
1 - BROWN	6 - BLUE
2 - RED	7 - VIOLET
3 - ORANGE	8 - GRAY
4 - YELLOW	9 - WHITE

3. SWITCH WAFERS ARE IDENTIFIED AS FOLLOWS:



EL5825-231-25-TM-142

FO-22. Trigger generator, schematic diagram.

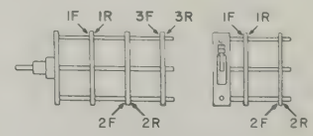


REFERENCE DESIGNATIONS

P/O A1
C100-106,110-113,120-122,125,126,130-136
CR101-110,114-117
J101
L101-103,110,111,115-120
P1, P2
Q101-112
R101-104,106-113,117-125,130-138, 145-158,165-169
S101-103,P/OS104
TP101
VR101,102

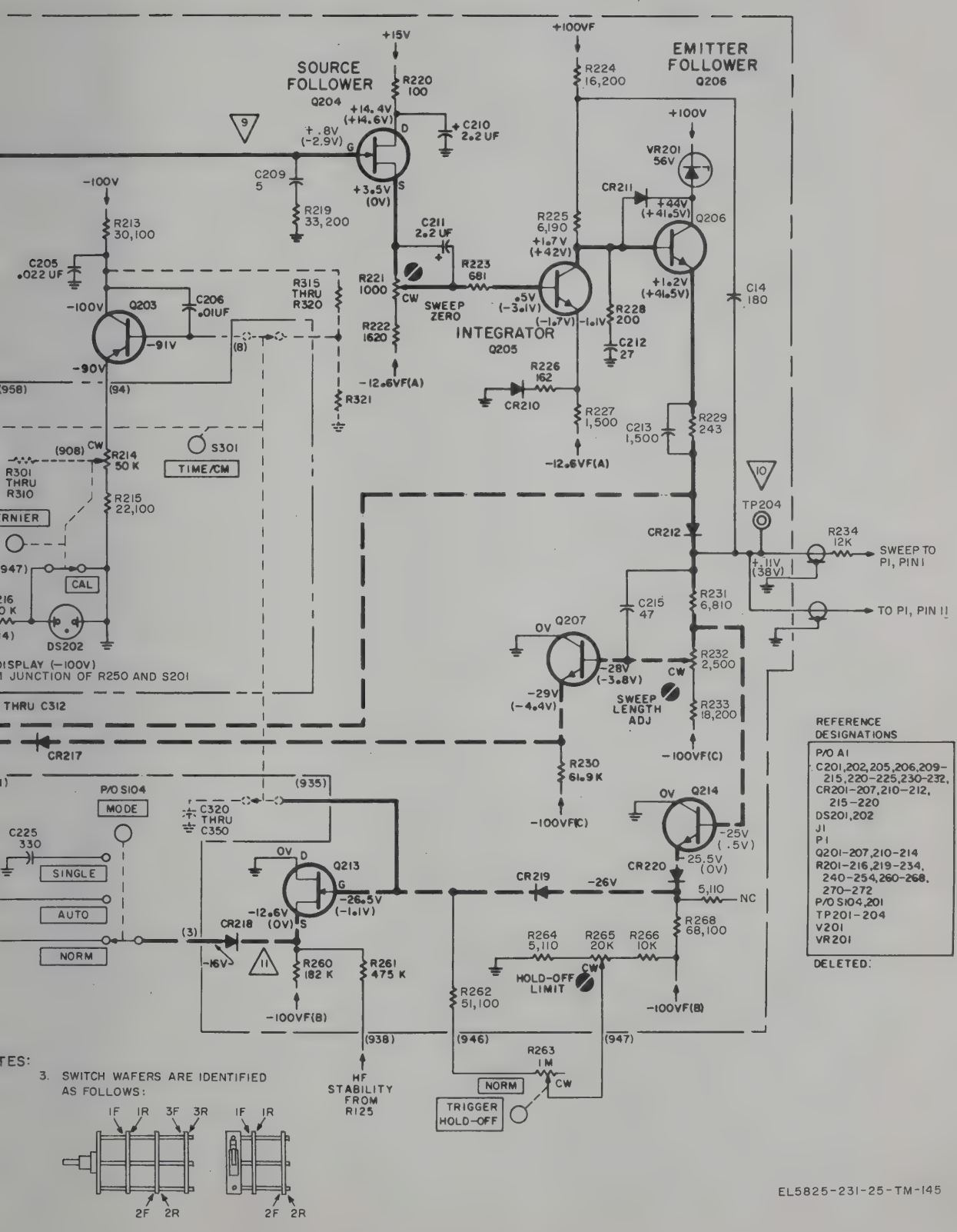
NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTANCES ARE IN OHMS.
   CAPACITANCES ARE IN PICOFARADS.
   INDUCTANCES ARE IN MICROHENRIES.
2. WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESES USING THE RESISTOR COLOR CODE (925 IS WHT-RED-GRN).
   0 - BLACK
   1 - BROWN
   2 - RED
   3 - ORANGE
   4 - YELLOW
   5 - GREEN
   6 - BLUE
   7 - VIOLET
   8 - GRAY
   9 - WHITE
3. SWITCH WAFERS ARE IDENTIFIED AS FOLLOWS:

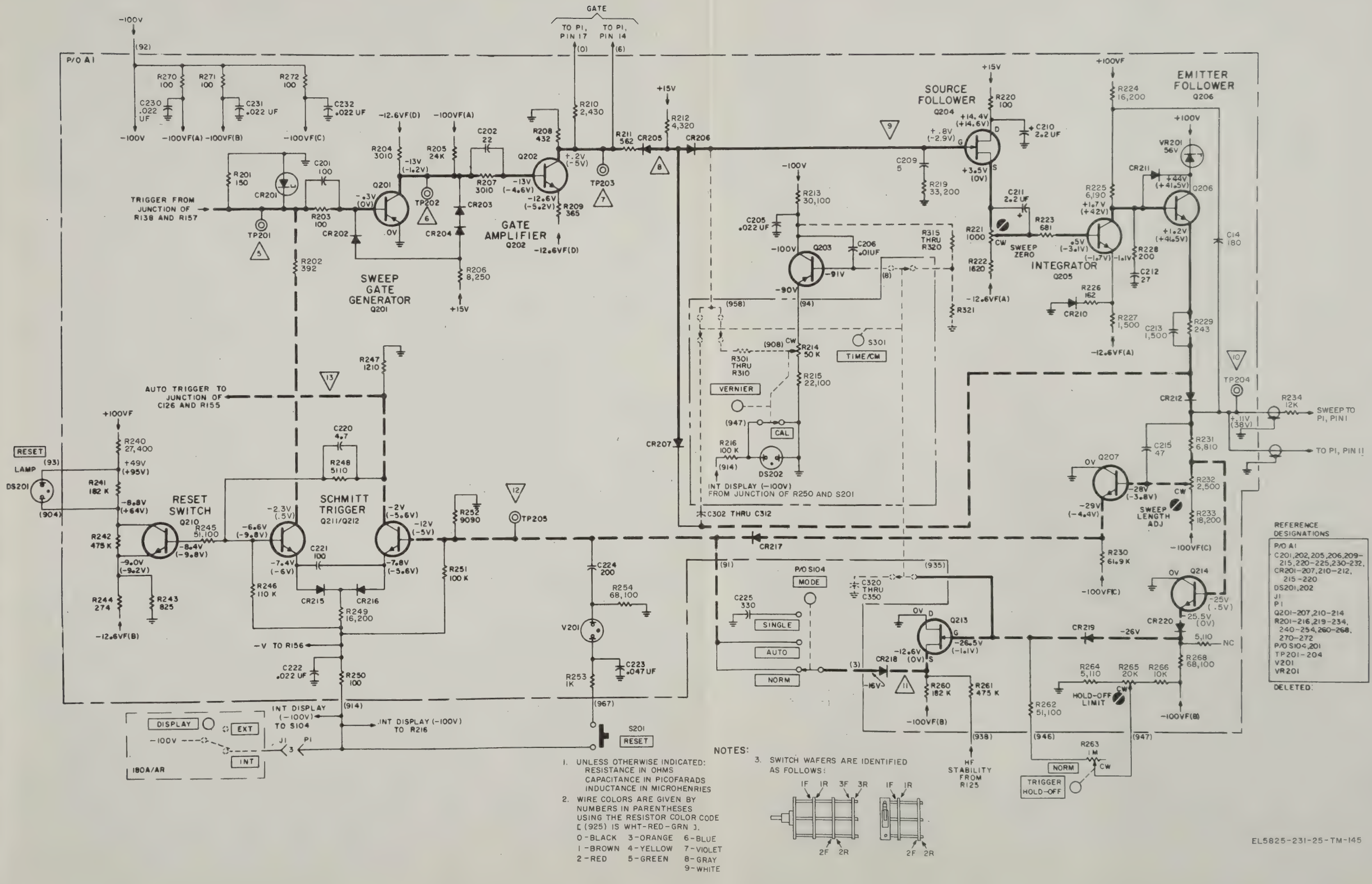


EL5825-231-25-TM-142

FO-22. Trigger generator, schematic diagram.



FO-23. Sweep generator, schematic diagram.

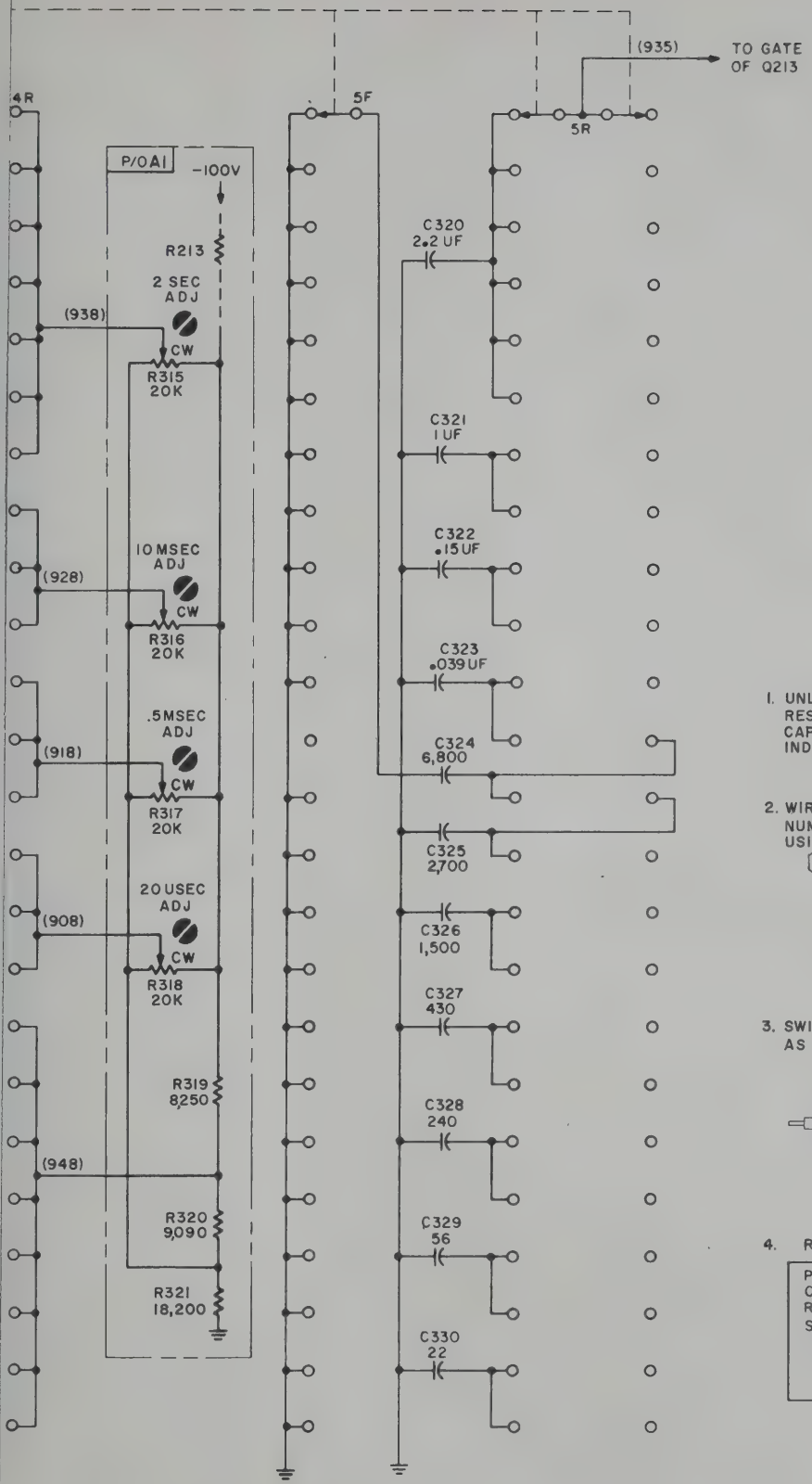


NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN PICOFARADS
   INDUCTANCE IN MICROHENRIES
2. WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESES USING THE RESISTOR COLOR CODE [(925) IS WHT-RED-GRN].
   0 - BLACK 3 - ORANGE 6 - BLUE
   1 - BROWN 4 - YELLOW 7 - VIOLET
   2 - RED 5 - GREEN 8 - GRAY
   9 - WHITE
3. SWITCH WAFERS ARE IDENTIFIED AS FOLLOWS:

EL5825-231-25-TM-145

FO-23. Sweep generator, schematic diagram.



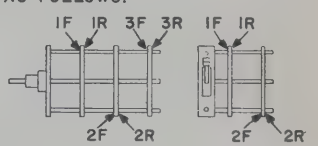
NOTES:

1. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS CAPACITANCE IN PICOFARADS INDUCTANCE IN MICROHENRIES.

2. WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESES USING THE RESISTOR COLOR CODE (925) IS WHT-RED-GRN

0-BLACK	5-GREEN
1-BROWN	6-BLUE
2-RED	7-VIOLET
3-ORANGE	8-GRAY
4-YELLOW	9-WHITE

3. SWITCH WAFERS ARE IDENTIFIED AS FOLLOWS:

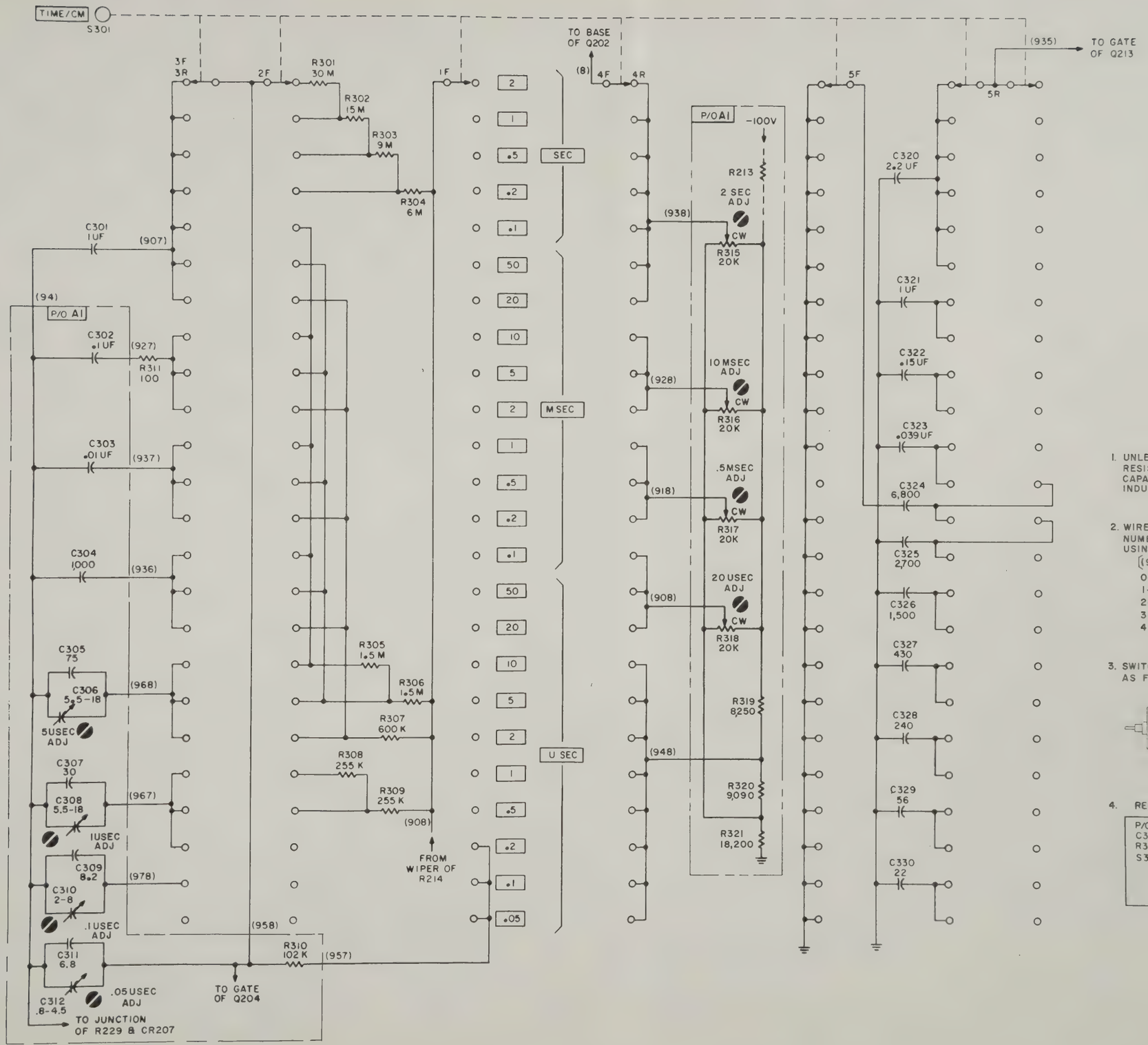


4. REFERENCE DESIGNATIONS

P/O A1
C301-312,320-330
R301-311,315-321
S301

EL5825-231-25-TM-146

FO-24. Sweep time switch, schematic diagram.



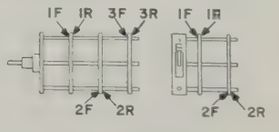
NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS
   CAPACITANCE IN PICOFARADS
   INDUCTANCE IN MICROHENRIES.

2. WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESES USING THE RESISTOR COLOR CODE (925) IS WHT-RED-GRN

0-BLACK	5-GREEN
1-BROWN	6-BLUE
2-RED	7-VIOLET
3-ORANGE	8-GRAY
4-YELLOW	9-WHITE

3. SWITCH WAFERS ARE IDENTIFIED AS FOLLOWS:



4. REFERENCE DESIGNATIONS

P/O A1
C301-312,320-330
R301-311,315-321
S301

EL5825-231-25-TM-146

FO-24. Sweep time switch, schematic diagram.

APPENDIX A

REFERENCES

The following is a list of references applicable to the organizational, and depot maintenance of Direction Finder Sets AN/TRD–23(*) and AN/TRD–15(*).

AR 700–52	Licensing and Control of Sources of Ionizing Radiation
AR 755–380	Disposal of Unwanted Radioactive Material
DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders
DA Pam 310–7	Index of Modification Work Orders
TB Sig 225	Identification and Handling of Radioactive Signal Items
SB 38–100	Preservation, Packaging, and Packing Materials, Supplies, and Equipment Used by the Army
TM 11–476	Radio Direction Finding
TM 11–688	Direction Finder Set AN/TRD–4A
TM 11–5820–358–10	Operator's Manual: Radio Receiver R–390A/URR
TM 11–5825–231–10	Operator's Manual: Direction Finder Sets AN/TRD–15, –15A, –23, and –23A
TM 11–5825–231–25	Organization, DS, GS, and Depot Maintenance Manual: Direction Finder Set AN/TRD–15
TM 11–6625–200–15	Operator's Organization, DS, GS, and Depot Maintenance Manual: Multimeters ME–26A/U, ME–26B/U, ME–26C/U, and ME–26D/U
TM 11–6625–274–12	Operator's and Organization Maintenance Manual: Test Sets, Electron Tube TV–7/U, TV–7A/U, TV–7B/U and TV–7D/U
TM 11–6625–320–12	Operator and Organization Maintenance Manual: Voltmeter, Meter ME–30A/U and Voltmeters, Electronic ME–30B/U, ME–30C/U, and ME–30E/U
TM 11–6625–351–12	Operator's and Organizational Maintenance Manual: Radio Interference Measuring Set AN/URM–83
TM 11–6625–366–15	Operator's, Organization, DS, GS, and Depot Maintenance Manual: Multimeter TS–352B/U
TM 11–6625–508–10	Operator's Manual: Signal Generators AN/USM–44 and AN/USM–44A
TM 11–6625–524–14	Operator, Organizational, and Field Maintenance Manual: Voltmeter, Electronic AN/URM–145
TM 11–6625–573–15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Signal Generator AN/GRM–50
TM 11–6625–602–12	Organizational Maintenance Manual Including Repair Parts and Special Tool Lists: Test Set, Telephone AN/USM–181
TM 11–6625–586–12	Operator and Organizational Maintenance Manual, Including Repair Parts and Special Tool Lists: Generator, Signal AN/URM–103
TM 11–6625–683–15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Signal Generator AN/URM–127
TM 11–6625–700–10	Operator's Manual: Digital Readout, Electronic Counter AN/USM–207
TM 11–6625–1703–15	Operator, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Oscilloscope AN/USM–281A
TM 38–750	The Army Maintenance Management Systems (TAMMS)

APPENDIX B

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

B-1. General

This appendix provides a summary of the maintenance operations covered in the equipment literature. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

B-2. Maintenance Functions

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.

b. Test. To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc. This is accomplished with external test equipment and does not include operation of the equipment and operator type tests using internal meters or indicating devices.

c. Service. To clean, to preserve, to charge, and to add fuel, lubricants, cooling agents, and air. If it is desired that elements, such as painting and lubricating, be defined separately, they may be so listed.

d. Adjust. To rectify to the extent necessary to bring into proper operating range.

e. Align. To adjust two or more components or assemblies of an electrical or mechanical system so that their functions are properly synchronized. This does not include setting the frequency control knob of radio receivers or transmitters to the desired frequency.

f. Calibrate. To determine the corrections to be made in the readings of instruments or test equipment used in precise measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.

g. Install. To set up for use in an operational environment such as an encampment, site, or vehicle.

h. Replace. To replace unserviceable items with serviceable like items.

i. Repair. To restore an item to serviceable condition through correction of a specific failure of unserviceable condition. This function includes, but is not limited to welding, grinding, riveting, straightening, and replacement of parts other than the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

j. Overhaul. Normally, the highest degree of maintenance performed by the Army in order to minimize timework in process is consistent with quality and economy of operation. It consists of that maintenance necessary to restore an item to completely serviceable condition as prescribed by maintenance standards in technical publications for each item of equipment. Overhaul normally does not return an item to like new, zero mileage, or zero hour condition.

k. Rebuild. The highest degree of materiel maintenance. It consists of restoring equipment as nearly as possible to new condition in accordance with original manufacturing standards. Rebuild is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance category. Rebuild reduces to zero the hours or miles the equipment, or component thereof, has been in use.

l. Symbols. The uppercase letter placed in the appropriate column indicates the lowest level at

which that particular maintenance function is to be performed.

B-3. Explanation of Format

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Functional Group. Column 2 lists the noun names of components, assemblies, subassemblies, and modules on which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the maintenance category at which performance of the specific maintenance function is authorized. Authorization to perform a function at any category also includes authorization to perform that function at higher categories. The codes used represent the various maintenance categories as follows:

Code	*Maintenance Category*
C	Operator/Crew
O	Organizational Maintenance
F	Direct Support Maintenance
H	General Support Maintenance
D	Depot Maintenance

d. Column 4, Tools and Test Equipment. Column 4 specifies, by code, those tools and test equipments required to perform the designated function. The numbers appearing in this column refer to specific tools and test equipment which are identified in table I.

e. Column 5, Remarks. Self-explanatory.

B-4. Explanation of Format of Table I, Tool and Test Equipment Requirements

The columns in table I, Tool and Test Equipment Requirements, are as follows:

a. Tools and Equipment. The numbers in this column coincide with the numbers used in the tools and equipment column of the applicable tool for the maintenance function.

b. Maintenance Category. The codes in this column indicate the maintenance category normally allocated the facility.

c. Nomenclature. This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

d. Federal Stock Number. This column lists the Federal stock number of the specific tool or test equipment.

e. Tool Number. Not used.

SECTION II. **MAINTENANCE ALLOCATION CHART**

GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											TOOLS AND EQUIPMENT	REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
	DIRECTION FINDER SET AN/TRD-15(*) and AN/TRD-23(*)	O												
			O										5,12	External voltage continuity, electron tubes
			F										2,3,6,7,8,9, 12,17	Test after troubleshooting and repair
			H										1-4,6-9,12,16, 17	
				O									15	
					F					F			13	
										H			13,14	
											D	D		
	ANTENNA SET, AN/TRA-32	O	O							F				
	ANTENNA ASSEMBLY AS-1882/GR									F				
	ANTENNA LOADING DISC MX-1168/GR								O					
	ANTENNA SECTION AT-442/GR								O					
	NETWORK, IMPEDANCE MATCHING ANTENNA SECTIONS, AT-443, 444, 445/GR								O					
	BASE, ANTENNA MT-865/GR								O					
	COUNTERPOISE, ANTENNA MX-4487/G								F					
	AMPLIFIER, ELECTRONIC CONTROL AM-3545/TRD			O										
			F						F		D	D	6-8,13	
	DETECTOR, RF, RF-159(*)/TRD		O										5,12	Voltage measurements, electron tubes
			F							F			2,3,6,7,8,12, 13,17,18,19	
											D	D		

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											TOOLS AND EQUIPMENT	REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
	DRIVE, GONIOMETER-ROTARY COUPLER TG-126(*)/TRD									F			13	
	BELT, POSITIVE DRIVE								F				13	
	COUPLER, ROTARY, RF									D			13,14	
	GONIOMETER, ELECTRICAL									H			13	
	INDICATOR, AZIMUTH, IP-669/TRD		O										5,12	
			F							F			3,6,7,8,12,13	
											D	D		
	OSCILLOSCOPE			O									15	
			F		F					F			3,4,6,7,8,12,13	
			H										3,4,6,7,8,11,16	
											D	D		
	PANEL, POWER DISTRIBUTION SB-1747/TRD									F				
											D	D		
	POWER SUPPLY PP-4482/TRD		O										5	
			F							F			6,7,13,17	
											D	D		
	RECEIVER, RADIO R-725/VRR	O	O	O									5,12,15	
			F		F	H				F			2,3,6,7,8,12,15,17	
	TRANSMITTER, RADIO T-279A/VR		O										5,12	
			F			H				F			2,3,6,7,8,12,13	
											D	D		

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											TOOLS AND EQUIPMENT	REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
	COUPLER, ANTENNA CU-187A/TRD-23A		O F							F	D	D	5 6,7,13,16,19	
	DISTRIBUTION BOX, AUDIO	O	F							F			13	

TABLE I. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOLS AND EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL STOCK NUMBER	TOOL NUMBER
1	H	ANALYZER SPECTRUM B-723/U	6625-668-9418	
2	F	COUNTER, DIGITAL READOUT AN/USM-207	6625-911-6368	
3	F	GENERATOR, SIGNAL SG-71/FCC	6625-669-0255	
4	F	GENERATOR, SIGNAL SG-299/U	6625-808-5584	
5	O	MULTIMETER AN/URM-105	6625-581-2036	
6	F	MULTIMETER ME-26/U	6625-360-2493	
7	F	MULTIMETER TS-352/U	6625-592-9302	
8	F	OSCILLOSCOPE AN/USM-281	6625-228-2201	
9	F	RF SIGNAL GENERATOR AN/URM-25	6625-643-1584	
10	D	SIMULATOR, ANTENNA		
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18	F	RF SIGNAL GENERATOR, AN/VRM-103	6625-868-8352	
19	F	AUDIO SIGNAL GENERATOR, AN/VRM-127	6625-783-5965	

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By Order of the Secretary of the Army:

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